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DETERMINATION OF DESIGN ALLOWABLE PROPERTIES FRACTURE OF 2219-T87 ALUMINUM ALLOY

By

Failure Mechanisms Research Organization

W. L. Engstrom, Principal Investigator



Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MANNED SPACECRAFT CENTER

Contract NAS 9-10364, Task 24

THE BUEING COMPANY

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Contract NAS 9-10364, Task 24

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FOREWORD

Aluminum alloy 2219–T87 has been determined to be one of the optimum materials available for fabrication of manned spacecraft tankage. In order to provide a comprehensive report of available data on fracture toughness, fatigue crack propagation and sustained load crack behavior, NASA requested the Aerospace Group of The Boeing Company to perform a literature search of 2219–T87 test data. This program was performed under NASA Contract NAS 9–10364, Task 24 from August 9, 1971 to February 15, 1972 and the results are reported herein. The work was administered under the direction of R. G. Forman at NASA/MSC.

Boeing personnel who participated in this investigation include J. N. Masters, Program Leader, and W. D. Bixler, W. L. Engstrom, R. W. Finger and R. C. Shah, Research Engineers, and C. Bilbao, Engineering Aide. Don Good prepared the art work.

The information contained in this report is also released as Boeing Document D180-14480-1.

DETERMINATION OF DESIGN ALLOWABLE PROPERTIES FRACTURE OF 2219-T87 ALUMINUM ALLOY

Ву

W. L. Engstrom

ABSTRACT

A literature survey was conducted to provide a comprehensive report of available valid data on tensile properties, fracture toughness, fatigue crack propagation and sustained load behavior of 2219–T87 aluminum alloy base metal and weldments as applicable to manned spacecraft tankage. Most of the data found were from tests conducted at room temperature, -320°F and -423°F. Data are presented in graphical and tabular form and areas in which data are lacking are established.

KEY WORDS

2219-T87 Aluminum Alloy
Manned Spacecraft
Weldments
Fracture Characteristics
Threshold Stress Intensity
Cyclic crack growth

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SYMBOLS

Flaw depth

Half flaw length

а

С

	•
С	Constant from Forman's equation for fatigue crack growth rates; also, used to denote compliance in stress intensity solutions for single edge notched specimens and tapered double cantilever beam specimens.
^d NOTCH	Diameter at the notch on a round notched bar fracture specimen
DBAR	Diameter of the bar for a round notched bar fracture specimen
Е	Young's Modulus
F _{tu}	Tensile ultimate strength
F _{ty}	Tensile yield strength
Ğ	Constant relating flaw opening displacement to flaw size and stress level
h	Height of a compact tension specimen or the short height of a tapered double cantilever beam specimen.
h ₁	Height of the highest end of a tapered double cantilever beam specimen.
K	Plane-stress stress intensity factor
K _I (IRWIN)	Irwin stress intensity factor for a surface flaw.
ĸ	Irwin stress intensity for a surface flaw with deep flaw magnification, M _K , included; also, plane-strain stress intensity factor for values reported in Appendix A.
K _{IE}	Critical stress intensity or plane strain fracture toughness for surface flaws, with $M_{\mbox{\scriptsize K}}$ included.
K _{TH}	Threshold stress intensity for surface flaw specimens.
L	Length of a specimen, length of test section.
^M K	Deep flaw magnification factor for 2219-T87 aluminum alloy base metal.

N Number of load cycles for fatigue test.

n Exponent from Forman's equation for fatigue crack growth rates.

NA Not available.

P Applied load

Q Flaw shape parameter = Φ^2 - 0.212 $(\sigma/\sigma_y)^2$

R Stress ratio, $(\sigma_{\min}/\sigma_{\max})$ for a cyclic fatigue crack growth test.

t Specimen thickness

Specimen thickness at the side groove on side grooved specimens.

w Specimen width

α Polar angle measured from the minor axis of a surface flaw

δ Flaw opening displacement

 μ Poisson's ratio

 σ Applied stress

 σ_{N} , σ_{NET} Net section stress

 $\sigma_{v'}$ σ_{YIELD} Yield stress

Complete elliptical integral of the second kind having modulus k defined as $k = (1 - a^2/c^2)^{1/2}$

> Greater than

< Less than

SUBSCRIPTS

i Initial condition

f Final condition

c Critical condition

max. Maximum condition

min. Minimum condition

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SUMMARY

The study described herein was undertaken to locate and report all available valid data on tensile properties, fracture toughness, fatigue crack propagation and sustained load crack behavior of 2219–T87 aluminum alloy base metal and weldments. The objective was to provide a comprehensive report which could be used in design of manned spacecraft tankage.

Most of the data found and reported were tested in room temperature air, liquid nitrogen at $-320^{\circ}F$ and liquid hydrogen at $-423^{\circ}F$. In addition, tensile data were located for tests conducted in dry ice and acetone at $-110^{\circ}F$ and in gaseous helium at $-423^{\circ}F$. Fatigue crack growth data were also found for tests conducted in salt water and helium at room temperature. Furthermore, sustained load data were also found for temperatures of $-230^{\circ}F$ and $-413^{\circ}F$ and environments of gaseous hydrogen, gaseous and liquid oxygen, oxygen difluoride (OF₂), FLOX (80% fluorine, 20% oxygen), $3\frac{1}{2}$ % salt water solution, distilled water, 172 decibel noise level, dye penetrant, argon, and trichloroethylene. The data are reported in graphical and tabular form.

During the course of this study, shortages of data were discovered in several areas. There were shortages of valid fracture toughness, sustained load and cyclic data of weldments, fracture properties of base metal in the RT propagation direction, and fracture toughness data in the WT direction at ~423°F. Properties were also found to be lacking at elevated temperatures and combined thermal and applied stress spectrum loadings. Furthermore, there were not enough data to firmly establish thickness effects for the properties investigated.

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1.0 INTRODUCTION

The objective of this investigation was to provide a comprehensive report of available data on fracture toughness, fatigue crack propagation and sustained load crack behavior of 2219-T87 aluminum alloy and weldments as applicable to manned spacecraft tankage. The majority of the useful fracture data obtained were from surface flawed specimens and they are covered in the main body of this report. Fracture data from other types of specimens were scarce and they are reported in Appendix A. A review of reports containing invalid or otherwise unusable data is contained in Appendix B. A summary of the quantities of tensile and surface flaw data in the main body of this report is shown below.

QUANTITIES OF TENSILE TESTS

TEMPERATURE	R	T	-11	0°F	-32	0°F	-423°F		
ENV MAT'L	ВМ	WM	ВМ	WM	ВМ	WM	ВМ	WM	
AIR	168	109							
DRY ICE +ACETONE			4						
LN ₂					69	93			
LH ₂							80	91	
GH _e							4		

QUANTITIES OF SURFACE FLAW FRACTURE TESTS

TEMPERATURE	R	Ţ	-32	0 ⁰ F	-423°F		
MAT'L ENV	вм	wM	ВМ	WM	вм	WM	
AIR	82						
LN ₂			72	2			
LH ₂					17	8	

QUANTITIES OF SURFACE FLAW FATIGUE CRACK GROWTH TESTS

TEMPERATURE	+400°F		+350 ⁰ F		+300°F		RT		320°F		~423°F	
ENV MAT'L	ВМ	wM	BM	WM	ВМ	WM	ВМ	WM	ВМ	WM	ВМ	WM
AIR	2		6		2		88	10				
GHe							3					
3.5% N₀Cl							11					
LN ₂									131	15		
LH ₂											34	10

QUANTITIES OF SURFACE FLAW SUSTAINED LOAD TESTS

TEMPERATURE	R	T	-23	-230°F		-320°F		~413°F		-423°F	
ENV. MAT'L	вм	WM	ВМ	ww	вм	wM	вм	WM	ВМ	WM	
AIR	<i>5</i> 4	8									
LN ₂					34	11					
LH ₂									15	2	
GH ₂	2	2			2	2	3	5			
LO ₂					2	2					
GO ₂	2	2									
OF ₂	2	3			2	2					
FLOX	3	2			2	2					
3.5% NaCl	6	2									
DISTILLED WATER	2	2									
172 db NOISE LEVEL	2		3								
DYE PENETRANT	2	2									
ARGON	2										
TRICHLORO- ETHYLENE	2	2									

2.0 PROCEDURES

2.1 SCREENING OF THE DATA

In order to ensure that only valid data would be reported, screening procedures were established. In some cases the screening eliminated much of the available data; however, this ensured the quality of the data presented herein. If a report did not appear to be accurate (e.g., improper use of stress intensity equation) all data from that report were eliminated. Data coming from remaining reports were then further screened to ensure that validity requirements were met for individual data points. Individual data points which did not meet validity requirements were eliminated, all data points which met validity criteria were included. Screening procedures are presented below for each type of test.

2.1.1 Tensile Data

Tensile data were inspected and an attempt was made to include only data which had been tested according to ASTM procedures (Ref. 1). Wherever tensile values did not appear reasonable, or specimen dimensions did not strictly match ASTM requirements, the text of the reference was carefully inspected to ensure that the data were indeed accurate. All accurate data were included in this report.

2.1.2 Fracture Toughness Data from Surface Flawed Specimens, $K_{\mbox{\scriptsize IE}}$

Most of the valid fracture data found in the literature were obtained from surface flawed fracture specimens. Fig. 1 shows a sketch of a typical surface flaw specimen and Fig. 2 shows the crack propagation orientation code. This specimen configuration has been especially popular in investigations of tankage materials because it can best approximate the actual defects commonly found. The main criteria for validity are as follows:

1.
$$\sigma_{N}/\sigma_{v} \leq 0.9$$

2.
$$w/2c > 4$$

3.
$$(t-\alpha) \geqslant 0.1 \left(\frac{\kappa_{IE}}{\sigma_{y}} \right)^{2}$$

Criterion 1. ensures that the failure is not dominated by net section yielding of the test specimen. Criterion 2. ensures that bending effects are at a minimum and it also aids in screening out net section effects and edge effects. Criterion 3. appears to be a limiting case for break before leak requirement. In the past, this criterion has been assumed to be $(t-a) \geqslant \frac{\pi}{16} \times (K_{|E}/\sigma_y)^2$; however, recent analysis of data generated under NASA Contract NAS 3-14341 (Ref. 2) indicates that the coefficient, $\frac{\pi}{16}$ (\approx 0.196), can be reduced to 0.1 for 2219-T87 aluminum alloy.

2.1.3 Fatigue Crack Growth and Sustained Load Data Obtained from Surface Flawed Specimens

Fatigue and sustained load data were not subjected to the strict criteria required of fracture toughness data. Most of the data obtained were tested at relatively high stresses. If the fracture toughness criteria were strictly enforced for sustained load and cyclic data, a great deal of data would have been eliminated. In general, most sustained load and fatigue data were used unless they obviously appeared to be in error. Test data were reported for w/2c ratios as low as 3.

2.2 SURFACE FLAWED SPECIMEN STRESS INTENSITY SOLUTION

The base metal fracture, fatigue, and sustained load data were adjusted for deep flaw effects using the empirical deep flaw magnification factor reported in Ref. 3 and shown in Fig. 3. The magnification factor was used to modify the Irwin stress intensity (Ref. 4) so that the resulting stress intensities were calculated as follows:

$$K_1 = \underbrace{1.1 \ \sigma \ (\pi \alpha/Q)^{1/2}}_{\text{Irwin Stress intensity}} M_K$$

where $K_i = Stress Intensity$

 σ = Gross stress

a = Flaw depth

Q = Flaw shape parameter (see Fig. 4)

 M_{κ} = Deep flaw magnification factor from Ref. 3 (see Fig. 3).

Ref. 3 has demonstrated that a deep flaw magnification may not be inherent in weld-ment fracture tests. Therefore, K_1 values for weldment tests were calculated without M_K .

3.0 DISCUSSION

3.1 TENSILE DATA

3.1.1 Base Metal Tensile Data

Most of the base metal data were generated in room temperature air, -320°F liquid nitrogen, or -423°F liquid hydrogen. Original thicknesses tested varied from 0.03 to 4.0 inches. Useful data were obtained from Refs. 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and 17. A normal distribution was assumed for the statistical analysis; however, no tests for goodness of fit were performed to verify this hypothesis. Ref. 18 was used as a guideline in the statistical analysis.

Ultimate strength, F_{tu}, and yield strength, F_{ty}, values for long addinal and long transverse grain base metal are summarized as a function of temperature in Figs. 5 and 6. Both mean and 99% probability, 95% confidence levels are shown. The "A" values from the Boeing Design Manual (Ref. 19) are also shown for reference. These "A" values correspond to the 99% probability, 95% confidence level. A summary of the base metal tensile values is tabulated in Tables 1 and 2.

Individual ultimate and yield strength data points are plotted as a function of thickness in Figs. 29 through 36, and the raw data points are tabulated in Tables 9 through 16. Figs. 29 and 30 indicate that for room temperature tests, there may be an increase in F_{tu} and F_{ty} properties in very thin gages (0.03 to 0.06 inches). The available data are not extensive enough to fully determine thickness effects in thin gages, therefore, data for all thicknesses were combined in this analysis.

Data available from the short transverse direction were limited to the points shown in Table 11. The scarce amount of data tested at -110°F in dry ice and acetone are shown in Table 12. Four tests at -423°F in a gaseous helium environment were included with the specimens tested in liquid hydrogen.

3.1.2 Gas Tungsten Arc Weldment Tensile Data

Most of the gas tungsten arc (GTA) weldment data was generated in room temperature air, -320°F liquid nitrogen, or -423°F liquid hydrogen. Original thicknesses tested

ranged from 0.10 to 1.00 inches. Wherever filler wire was used, the filler material was 2319 aluminum alloy. The majority of the data were not heat treated after welding although some limited data were found for specimens aged after welding and also for some specimens which were solution treated and aged (STA) after welding. Useful data were obtained from Refs. 3, 6, 12, 15, 16, 17 and 20. The statistical analysis was the same as that described in Section 3.1.1.

The GTA welded tests without a post weld heat treatment are summarized as a function of temperature in Fig. 7. Most of the available data consisted of ultimate strength values only. Because of a shortage of yield strength values, only "apparent" mean yield strengths can be reported, and no 99% probability, 95% confidence level values of yield strength could be calculated. The available data were sufficient to show mean and 99% probability, 95% confidence levels for ultimate strength. "A" values from Ref. 19 for ultimate and yield strength values are also shown in Fig. 7. A summary of F_{tu} and F_{ty} values for GTA welded material without post weld heat treatment is also shown tabulated in Table 3.

Individual ultimate and yield strength data points for GTA weldments without post weld heat treatment are shown plotted as a function of thickness in Figs. 37 through 42, and the raw data points are tabulated in Tables 17 through 19. Not enough data were available to fully determine thickness effects on material properties, therefore, all thicknesses were combined for this analysis.

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Those GTA weldment data points subjected to a post weld age and a post weld solution treat and age are shown plotted versus thickness in Figs. 43 and 44 respectively. Individual values are listed in Tables 20 and 21. There were not enough data points available to firmly establish mean or 99% probability, 95% confidence levels.

3.1.3 Gas Metal Arc Weldment Tensile Data

All of the gas metal arc (GMA) weldment data come from Ref. 17. Plate material data in original thicknesses of 0.5, 1.0 and 1.5 inches were available for tests conducted in room temperature air, -320°F liquid nitrogen and -423°F liquid hydrogen. The filler wire used was 2319 aluminum alloy. Only ultimate strength

values were reported. A summary of the ultimate strength values is shown in Fig. 8 and tabulated in Table 4. As in the previously reported data, "A" values from Ref. 19 are shown for comparison. The statistical analysis if described in Section 3.1.1.

Individual ultimate strength data are plotted as a function of thickness in Figs. 45, 46 and 47 and the raw data points are listed in Tables 22, 23 and 24. Not enough data are available to firmly establish thickness effects; however, examination of Figs. 45, 46 and 47 indicates that as the temperature decreases, the 0.5 thick weldments exhibit a greater average strength increase than do the 1.0 and 1.5 inch thick weldments.

3.2 FRACTURE DATA

3.2.1 Base Metal Surface Flawed Fracture Toughness Data

Surface flawed fracture toughness data were aviiable from tests in room temperature air, -320°F liquid nitrogen and -423°F liquid hydrogen. Usable data were obtained from Refs. 2, 3, 6, 13, 14, 15, 21, 22, 23 and 24. The thicknesses of valid data points ranged from 0.25 to 1.25 inches, with the majority of the data lying in the range of 0.5 to 0.65 inch. Tests conducted on gages thinner than 0.25 inch were generally disqualified because the remaining ligament size, t-a was less than 0.1 $(K_{1E}/\sigma_{\gamma})^2$.

Data obtained for RT and WT propagation directions are summarized as a function of temperature in Fig. 9 and Table 5. Because of the scarcity of data in the RT direction at -423°F and room temperature, and in the WT direction at -423°F, only "apparent" mean values are reported for these conditions. The data indicate that fracture toughness values for the WT propagation direction are lower than those for the RT propagation direction.

Individual fracture toughness values are plotted as a function of thickness in Figs. 48 through 53, and raw data points are listed in Tables 25 through 30. Mean or "apparent" mean values are shown and where possible, 99% probability, 95% confidence levels are also shown. The statistical analysis is described in Section 3.1.1.

3.2.2 Weldment Surface Flawed Fracture Toughness Data

Valid surface flawed fracture toughness values for weldments were almost nonexistent. Those values which fulfilled the validity requirements all came from Ref. 3. No data were available for room temperature, two data points were available for -320°F and eight data points were available for -423°F. All ten of these data points were obtained from GTA weldments of 1.0 inch plate material. The data are summarized in Table 6 and individual data points are plotted as a function of thickness in Fig. 54, and are listed in Tables 31 and 32.

The low yield strength of weldment material requires testing of large panels in order to meet the validity requirements for net yield strength ($\sigma_{N} \leqslant 0.9 \, \sigma_{y}$), and ligament size (t-a) $\geqslant 0.1 \, (K_{|E}/\sigma_{y})^{2}$. The panels tested in Ref. 3 ranged in size up to 30 inches wide. The testing of such panels requires extremely high load capabilities of testing facilities. The major reason for the shortage of "valid" weldment fracture toughness data stems from the apparent high toughness/low yield strength combination.

3.3 SUSTAINED LOAD DATA

All sustained load data found in the literature were for tests which were on the order of 100 hours or less in duration. Hyatt and Speidel have shown that proper determination of a threshold can be dependent on the length of the test (Ref. 25). Therefore, the threshold values reported herein have been qualified by noting the duration of the tests.

Another factor which must be taken into consideration is growth-on-loading. This phenomenon is non-environmentally induced growth which occurs on initial loading of a specimen. In order to determine sustained load growth, it is necessary to subtract growth-on-loading from total growth incurred during a test. Growth-on-loading as a function of initial stress intensity is shown for base metal in Fig. 10 and for weldments in Fig. 11. These curves were taken from data generated in Refs. 2 and 22 respectively. As shown by these two figures, precise separation of growth-on-loading from total growth to determine environmental growth can be difficult. This further emphasizes the need to report test times along with threshold values.

Average crack growth rates as a function of time, da/dt, could not be obtained because of the problem in separating environmentally induced growth from growth-on-loading. Likewise, good instrumented test results producing instantaneous growth rates were not available either. Therefore, no K versus aa/dt data are reported herein.

3.3.1 Base Metal Surface Flawed Sustained Load Data

Surface flawed sustained load data were found for base metal tests at room temperature, -230°F , -320°F , -413°F and -423°F in environments of air, $3\frac{1}{2}\%$ salt water solution, distilled water, dye penetrant, FLOX (80% F_2 , 20% O_2), oxygen difluoride (OF₂), Argon, Trichloroethylene, 172 decibel noise level, liquid nitrogen, gaseous and liquid oxygen, and gaseous and liquid hydrogen. Thicknesses varied from 0.125 to 1.00 inch. Useful base metal sustained load data were obtained from Refs. 5, 6, 14, 22 and 24. In addition, some data were obtained from Refs. 23 and 26; however, these data were not complete enough for use in establishing thresholds.

Threshold values are summarized in Table 7 . Where a value is reported qualified with a less than, < , or greater than, > , symbol, not enough data were available for a precise determination of the threshold; however, enough data were available to provide an approximation of the threshold. In order to report the threshold as a percentage of critical stress intensity, K_{TH}/K_{IE} value, it was necessary to choose a K_{IE} value. Wherever possible, the endpoint critical stress intensity, K_{IE} , value for each particular threshold specimen was used. If the endpoint for a particular specimen was not available, then the average K_{IE} value for all the K_{IE} tests in the same reference was chosen. Finally, if neither of the above K_{IE} values was available, then K_{IE} was chosen from the overall mean of data points from the particular propagation direction and temperature in question. The source of the K_{IE} value is reported with each threshold value. Individual test datum points are listed in Tables 33 through 37.

In most cases, only a few data points were available and the threshold was chosen by determining the highest K level at which all growth appeared to be growth-on-loading only. For some of the threshold determinations, many data were available and so the data could be plotted to determine threshold. An example of such a

plot is shown in Fig. 12.

In general, for most environments, a threshold level on the order of 85% can be assumed for approximately 24 hours. With the exception of tests from Ref. 5, in liquid hydrogen at -423° F, all thresholds were at least 82% of the critical stress intensity value. The threshold level of the LH₂ data from Ref. 5 was found to be in the range of 35.6 to 38.4 ksi $\sqrt{\text{in.}}$ Combining these figures with the overall apparent mean K_{1E} value of 47.0 ksi $\sqrt{\text{in}}$ produces threshold/critical stress intensity ratios of 0.75 to 0.82. The low threshold ratios determined here could be accounted for by the selection of a critical stress intensity that was too high. If actual endpoint K_{1E} values were available, the threshold ratio reported could be higher.

3.3.2 Weldment Surface Flawed Sustained Load Data

Surface flawed sustained load data were found for weldment tests at room temperature, -320°F , -413°F and -423°F in environments of air, $3\frac{1}{2}\%$ salt water solution, distilled water, dye penetrant, FLOX (80% $\frac{1}{2}$, 20% O_2), oxygen difluoride (OF₂), trichloroethylene, liquid nitrogen, gaseous and liquid oxygen, and gaseous and liquid hydrogen. Data were reported in thickness of 0.90, 0.95 and 1.00 inch. Useful weldment sustained load data were obtained from Refs. 22 and 23. In addition, some data were obtained from Ref. 24. However, most of the data from Ref. 24 were tested at very high stress levels so that threshold levels could not be determined from them.

Threshold values are summarized in Table 8. Because of the scarcity of weldment fracture toughness data, no attempt was made to report thresholds in terms of a percentage of critical stress intensity. The analysis of weldment data was similar to that employed for base metal data.

The available data indicate thresholds on the order of 23-30 ksi $\sqrt{\text{in}}$ for all environments with the exception of $3\frac{1}{2}\%$ salt water solution. The data show that the threshold for this environment lies somewhere below 23.8 ksi $\sqrt{\text{in}}$.

Individual datum points are listed in Tables 38 through 41.

3.4 FATIGUE DATA

3.4.1 Base Metal Fatigue Crack Growth Data

Base metal fatigue crack growth data were generated in air, gaseous helium, $3\frac{1}{2}\%$ salt water solution, liquid nitrogen and liquid hydrogen. Test temperatures were room temperature, $-320^{\circ}F$, $-423^{\circ}F$, $+300^{\circ}F$, $+350^{\circ}F$ and $+400^{\circ}F$. Data were obtained from References 2, 3, 5, 6, 13, 14, 23 and 26.

Thicknesses of test specimens ranged from 0.125 to 1.25 Inches. Cyclic stresses ranged from 7 ksi to 65 ksi and stress ratios, R, ranged from 0.0 to 0.5 with the majority of the data tested at R=0.0 to 0.1. Test frequencies ranged from 0.008 to 120 cpm. Typical cyclic loading profiles are shown in Fig. 13 and individual data points are summarized in Tables 42 through 50.

Data were found to be lacking in the RT propagation direction at room temperature, -320°F and -423°F. One of the reasons for a shortage of data in the RT direction is that delamination commonly occurs in specimens which are tested in this direction, especially at room temperature. While this makes testing difficult in the RT direction, it is beneficial in hardware because the delamination also causes a retardation in crack growth.

Figures 14 to 16 show the relationship between stress intensity ratio, K_{II}/K_{IE} to cycles to failure, N, for the environments of ambient air, liquid nitrogen and liquid hydrogen. Examination of these plots indicates that the polynomial function of \log_{10} N, shown below, would best represent the data:

$$K_{II}/K_{IE} = A + B \log_{10} N + C(\log_{10} N)^2 + D(\log_{10} N)^3 + E(\log_{10} N)^4$$

Since the rotto of stress intensities K_{II}/K_{IE} contain errors due to measurement of flaw sizes, computations of stress intensities from stress intensity equations, etc., K_{II}/K_{IE} is taken as a dependent variable and N as an independent variable. The polynomial function was limited to the fourth order of $\log_{10}N$ to avoid oscillations between fitted points.

Data for each of the plots of Figures 14 to 16 were successively least square fitted

with the second, third and fourth degree polynomials of $\log_{10} N$. Out of these curves, the one which best describes the data was selected and the best fit least square cruve with the equation is shown in each figure.

Crack growth rates da/dN and d(a/Q)/dN were computed from either average or instantaneous crack growth measurements. Measured average growth rates were determined by taking the difference between the final and initial flaw sizes and dividing this quantity by the number of cycles. The corresponding stress intensity value was taken as the average maximum stress intensity during the test.

Instantaneous growth rate data were available from Refs. 2 and 5. Instantaneous growth rate data were determined by instrumenting specimens with ASTM type crack opening displacement, δ , clip gages.

The clip gage was spring loaded against knife edges spot welded to the specimen. An expression for the opening displacements of a completely embedded flaw was provided by Green and Sneddon (Ref. 27). The flaw embedded in an elastic solid was subjected to a uniform load normal to the crack surface at infinity. The maximum opening displacement occurs at the diametrical center of the crack and is expressed by the equation:

$$\delta = \frac{4(1 - \mu^2)}{E} \frac{\sigma \alpha}{\Phi}$$

Although a rigorous solution is not available for flaw opening displacements for a semi-elliptical surface flaw, such displacements should also be proportional to σ and a/Φ for elastic materials. By following Irwin's procedure (Ref. 4) to account for the effect of plastic yielding, the flaw opening displacement, δ , for a surface flaw can be approximated by

$$\delta = G \frac{\sigma}{\sqrt{Q}}$$

where G is a constant. The value of G can be determined by knowledge of initial and final flaw sizes and the change in flaw opening displacement as indicated below:

$$G = \frac{\delta_f - \delta_i}{(\alpha / Q)_f - (\alpha / Q)_i}$$

Knowing the above constant, the instantaneous flaw size can be estimated and, therefore, the instantaneous flaw growth rates can be calculated.

Crack growth rates da/dN and d(a/Q)/dN were plotted as a function of stress intensity and summary curves of the results are shown in Figs. 17 through 25. Individual da/dN data points are plotted in Figures 55 through 98 and individual d(a/Q)/dN data points are plotted in Figures 106 through 149. Data are identified as instantaneous or measured average growth rates.

Forman, Kearney and Engle (Ref. 28) have proposed a fatigue crack propagation model of the form:

$$da/dN = \frac{C \left(\Delta K_{l}\right)^{n}}{(1 - R)K_{cr} - \Delta K_{l}}$$

fatigue crack growth rate da/dN where:

 ΔK_{1} cyclic stress intensity range

= critical stress intensity KIF

= stress ratio, minimum stress/maximum stress

C,n empirically determined constants

Forman's equation can be rewritten as log
$$\{[(1 - R) K_{|E} - \Delta K_{|}] da/dN\}$$

= $\log C + n \log \Delta K_{|E} = C_{|E} + nx$

which is an equation of a straight line. The constants C and n were determined by fitting crack growth rate data da/dN with ΔK_{\parallel} and K_{\parallel} with the least square method wherever possible. The resulting constant C and exponent n for each of the summary da/dN plots in Figures 17 to 23 are shown.

3.4.2 Weldment Fatigue Crack Growth Data

There was a severe shortage of weldment fatigue crack growth data. were found in Refs. 3 and 23 for tests conducted in room temperature air, liquid nitrogen at -320°F and liquid hydrogen at -423°F.

Thicknesses ranged from 0.125 to 1.00 inch. Cyclic stresses ranged from 13 to 25 ksi with stress ratios of 0.0 or 0.1. Test frequencies were 1 or 20 cpm. Typical cyclic loading profiles are shown in Fig. 13 and individual data points are summarized in Tables 51, 52 and 53. Figures 26, 27 and 28 show summary plots of crack growth rates da/dN and d(a/Q)/dN.

Individual da/dN data points are plotted in Figures 99 through 105, and individual d(a/Q)/dN data points are plotted in Figures 150 through 156.

In order to obtain cyclic flaw growth rates from the weldment data presented in Ref. 3, it was necessary to assume a manner in which the crack length varied during the cyclic test. For the 0.125 inch thick specimens (a/2c initial = 0.05) it was assumed that the crack length remained constant throughout the tests. For the 1.00 inch thick specimen (a/2c initial = 0.30) it was assumed that the flaw aspect ratio remained constant. Experience has shown these assumptions to be quite reasonable.

4.0 RECOMMENDATIONS

During the course of this study, it was found that data are lacking in several areas. In general, there were very little data at elevated temperatures. Also, there were virtually no data on the interaction of changing thermal and loading conditions such as might be encountered by tankage during flight. Investigation of the effects of such spectrum loading on flaw growth is needed in order to more accurately predict life expectancies of tankage. It was also found that there are few data to fully determine thickness effects on all properties investigated.

In addition to the general areas described above, more specific areas in which data are lacking are listed below:

1. Fracture Toughness Data

- a. Base Metal Data are lacking in the RT propagation direction at room temperature and -423°F, and in the WT direction at -423°F.

 The lack of data in the RT direction is caused mainly by the fact that the material has a tendency to delaminate in this direction.
- b. Weldments Extensive valid testing of weldments is recommended.

 Only ten valid test points were found, two at -320°F and eight at -423°F. This shortage of valid test points is caused by the apparent high toughness, low yield strength combination found in weldments.

2. Sustained Load Data

a. Base Metal - Data for room temperature air, liquid nitrogen at -320°F and liquid hydrogen at -423°F appear to be adequate for the WT propagation direction. While data in the RT direction are lacking, it is anticipated that the WT direction would be the worst case, because of delamination (and hence, crack growth retardation) which has been shown to occur in the RT direction. In addition, some data are available on environments other than room air, LN₂ and LH₂. It is recommended that if applications are found for environments other than those for which thresholds are reported herein, then those environments should be tested to ensure a reasonable life expectancy of the hardware.

b. Weldments - It is recommended that further testing of weldments be undertaken to confirm the results reported herein for particular applications, especially in a $3\frac{1}{2}\%$ salt water environment.

One of the greatest problems in using weldment threshold data in design is caused by the shortage of valid weldment fracture data. Without valid toughness values, threshold ratios, K_{TH}/K_{IE} , used in design, cannot be determined.

3. Cyclic Flaw Growth Data

- a. Base Metal Additional testing is needed at room temperature, -320°F, and -423°F in the RT propagation direction. As stated above, the shortage of data in the RT direction is mainly caused by the fact that 2219-T87 alloy has a tendency to delaminate in this direction. Cyclic flaw growth data are also lacking at R ratios other than 0.0 to 0.1.
- b. Weldments There is a general shortage of weldment cyclic growth data at all temperatures of interest. It is recommended that this area be investigated extensively.

APPENDIX A - OTHER DATA

Ai.0 INTRODUCTION

All available surface flaw data are contained in the main body of this report. The limited amount of data from other types of fracture specimens are reported in this Appendix. These data all consist of tests on base metal material. A summary of the number of data points found for each type of test is shown below:

QUANTITIES OF OTHER BASE METAL TESTS

ENVIRONMENT				
TEST TYPE	3.5% NaCI	AIR@RT	LN ₂ @ -320°F	LH ₂ @ -423°F
SENT K		4		
C.T. K _{lc}		2	2	2
SENB K		2	2	2
TAPERED DCB FATIGUE	6			
T-T-T CENTER NOTCH K		15	4	13
T-T-T CENTER NOTCH FATIGUE		8	10	8

A2.0 PROCEDURES

A2.1 SCREENING OF THE DATA

In order to ensure that only valid data would be reported, the screening procedures outlined below were established. In addition, data were not included from reports which did not appear to be accurate. The various types of fracture specimens from which data points were obtained and the crack propagation code are shown in Figures A-1 and A-2.

A2.1.1 Plane Strain Fracture Toughness, K_{Ic}, Data from Through-the-Thickness and Round Notched Bar Specimens

Through-the-thickness data found in the literature included data from the following types of specimens: compact tension (CT), single edge notched bend (SENB), single edge notched tension (SENT), and tapered double cantilever beam (TDCB). The following ASTM criteria (Ref. 29) were used to screen this data:

- 1. $t \geqslant 2.5 \left(\frac{K_{lc}}{\sigma_{y}} \right)^{2}$
- 2. $a \ge 2.5 (K_{ic}/\sigma_{v})^{2}$ (not required for TDCB specimens)
- 3. Permanent crack opening displacement (COD) at 80% of $P_{critical} \leq 25\%$ of COD at $P_{critical}$ on load versus COD Trace (CT and SENB specimens)

The load traces were generally no available, therefore, it was not always possible to determine if criterion 3 was satisfied. A limited amount of valid data was found for CT, SENB, and SENT specimens.

The following criteria were used to validate round notched bar data:

- 1. $\sigma_{N}/\sigma_{v} \leq 1.0$
- 2. $d_{NOTCH}/D_{BAR} = 0.4 \text{ to } 0.6$
- 3. Notch angle = 30° to 60°

No valid round notched bar data were obtained.

A2.1.2 Plane Stress Fracture Toughness, K_c, Data from Through-the-Thickness Center Notched Panels

Plane stress fracture toughness data were collected only from those specimens for which $\sigma_{N}/\sigma_{v} \leqslant$ 0.8.

A2.1.3 Plane Strain Fatigue Crack Growth and Sustained Load Data from Through-the-Thickness Specimens

The thickness and crack length requirements employed for fracture tests were also used for fatigue crack growth and sustained tests. The only valid fatigue data obtained from specimens other than surface flawed specimens were obtained from TDCB specimens. No valid sustained load data were obtained from specimens other than surface flawed specimens.

A2.1.4 Plane Stress Fatigue Crack Growth and Sustained Load

Data from Through-the-Thickness Center Notched Panels

Only a limited amount of fatigue data were available and they fell within the $\sigma_{\rm N}/\sigma_{\rm y} \leqslant$ 0.8 guideline. No sustained load data were found.

A2.2 STRESS INTENSITY SOLUTIONS

A2.2.1 Compact Tension Specimens

The stress intensities for compact tension specimens were calculated using the relation:

$$K_1 = P/tw^{1/2} F_1 (\alpha/w)$$

where

K₁ = Plane Strain Stress intensity

P = Load

t = Thickness of Specimen

w = Width of specimen

 $F_1(a/w) = Geometry factor from Ref. 15 (see Fig. A-3).$

A2.2.2 Three Point Loaded Single Edge Notch Bend Specimens

Stress intensities for 3 point loaded single edge notched bend specimens were calculated using the relation

$$K_1 = PL/tw^{3/2} F_2 (a/w)$$

where

K, = Plane Strain Stress Intensity

P = Load

L = Span between load points at each end of the specimen

t = Thickness of specimen

w = Width of specimen

 $F_2(a/w)$ = Geometry factor from Ref. 15 (see Fig. A-3)

A2.2.3 Single Edge Notched Tension Specimens

Stress intensities for SENT specimens were calculated using an experimental compliance calibration described in Ref. 30. The compliance calibration is performed by loading a specimen with varying crack lengths and measuring compliance. The rate of change of compliance with respect to crack length is then incorporated into a relation proposed by Irwin (Ref. 31). The resulting equation is of the form:

$$K_1 = P/\sqrt{2} \left(E/(1-\mu^2) \cdot dC/da \right)^{1/2}$$

where

K₁ = Plane strain stress intensity

P = Load

E = Young's modulus

 μ = Poisson's ratio

C = compliance

a = crack length

A2.2.4 Tapered Double Cantilever Beam Specimens

Stress intensities for tapered double cantilever beam (TDCB) specimens were calculated using the following equation from Ref. 5:

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$$K_1 = P/\sqrt{2t_g} \left(E/(1-\mu^2) - dC/da\right)^{1/2}$$

where

K₁ = Plane strain stress intensity

P = Load

t_ = Thickness at the groove (specimens were side grooved)

E = Young's modulus

μ = Poisson's ratio

C = Compliance

a = Crack length

This equation is derived from Irwin's analysis (Ref. 31). For the specimens reported herein, the design of the taper was such that the quantity dC/da was a constant. Thus the stress intensity becomes a function of variation in load only.

A2.2.5 Plane Stress Through-the-Thickness Center Notched Specimens

Stress Intensity factors for through—the—thickness center notched specimens were calculated using the "secant formula" proposed by Fedderson in Ref. 32. It is as follows:

$$K = \sigma \sqrt{\pi c} \cdot \sqrt{\sec(\pi c/w)}$$

where

K = Plane stress stress intensity

 σ = gross stress

c = half crack length

w = panel width

A3.0 DISCUSSION

A3.1 FRACTURE DATA

A3.1.1 Through-the-Thickness Plane Strain Fracture Toughness, K_{1c}, Data

The available valid through-the-thickness plane strain fracture toughness data were limited in quantity. Some data were found in Ref. 15 for compact tension (CT) and three point loaded bend (SENB) specimens. They are reported in Tables A1 and A2. These specimens were tested in room temperature air, liquid nitrogen at -320°F and liquid hydrogen at -423°F. The propagation direction was WT. The fracture toughness values of the CT specimens were somewhat below those reported for the SENB specimens. Except in the case of SENB specimens tested at -423°F, the CT and SENB specimens exhibited lower toughness than the surface flawed (SF) specimens covered in the main body of the report. These phenomena were demonstrated earlier by Hall and Finger in Ref. 15.

Single edge notch tension specimens tested at room temperature were found in Ref. 9 for the RW and WR propagation direction. They are reported in Table A-3. No other plane strain data from other specimens with these propagation directions are available for comparison. However, the values reported appear to be somewhat lower than data from SENB tests in the WT direction and surface flaw tests in the WT and RT directions.

A3.1.2 Through-the-Thickness Plane Stress Fracture Toughness, K_c, Data

Plane stress fracture data from through-the-thickness center notched panels were found in Refs. 8, 10, 33 and 34. Test temperatures were room temperature, -320°F and -423°F, and propagation directions were WR and RW. The data are reported in Tables A-4, A-5 and A-6. In addition, endpoint critical stress intensities of cyclic tests can be found in Tables A-7, A-8 and A-9. The fracture toughness data are summarized as a function of thickness in Figs. A-4, A-5 and A-6. Because of disparities in the methods of crack initiation, and the wide scattering of the data, no attempt is made at analysis. The data are presented herein only to show what is available in the literature.

A3.2 SUSTAINED LOAD AND FATIGUE DATA

A3.2.1 Through-the-Thickness Plane Strain Sustained Load and Fatigue Crack Growth Data

No plane strain sustained load data were found; however, some cyclic growth data for tapered double cantilever bend specimens were found in Ref. 5. These specimens were cycled in room temperature $3\frac{1}{2}\%$ salt water solution. Propagation direction was WR. The data are reported in Table A-10 and cyclic crack growth rates are shown in Fig. A-7. No other data are available for comparison.

A3.2.2 Through-the-Thickness Plane Stress Sustained Load and Fatigue Crack Growth Data

No plane stress sustained load data were found; however, some cyclic growth data for through-the-thickness center notched panels were found in Ref. 8. These specimens were cycled in room temperature air, liquid nitrogen at -320°F and liquid hydrogen at -423°F. Test results are tabulated in Tables A-7, A-8 and A-9. The data were not available in a form readily usable, because instantaneous growth rates were not available. However, average stress intensities and average growth rates were calculated and these values are shown graphically in Fig. A-8. The data were not suitable for a detailed analysis.

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APPENDIX B - REPORTS CONTAINING INVALID OR OTHERWISE UNUSABLE DATA

During the course of this study, many reports were found containing data which could not be used in this analysis for various reasons. In order to provide a single listing for easy reference in future studies, the reports containing this data are described below.

Additional base metal tensile data were found in Refs. 35 through 50. Data from these references were not included because the data were typical or average values, or they were meant for special applications. Of these references, 41, 49 and 50 were of particular interest. Ref. 41 was a survey of tensile values for material ranging in thickness from 0.040 inch to 5.00 inches; including tensile values from various locations in thick plate. Ref. 49 provided typical values for several different alloys. Ref. 50 reported the effect of magnetic forming on tensile values.

Additional weld metal tensile data were found in Refs. 39, 51 and 52. Data from Refs. 39 and 51 were typical values, while Ref. 52 provided a study of weldment properties at different weldment locations (weld centerline, fusion line, heat affected zone).

Additional fracture data were found in Refs. 2, 11, 16, 17, 26, 34, 36, 38, 46, 52, 53 and 54. Ref. 36 contained only typical values of fracture toughness. Invalid K_{lc} values for notched bend, single edge notched tension, and round notched bars were found in Refs. 11, 46, and 34 respectively. Ref. 17 contained data from charpy and ref. tear specimens. Invalid weldment fracture tests conducted on single edge notched bend, single edge notched tension, and double cantilever beam specimens were found in Ref. 52. Ref. 26 contained a plot of fatigue crack growth rate data for compact tension specimens; however, these were unpublished data from the Space Division of North American Rockwell, and the tabular values were not available to this author. Through-the-thickness center notched tests for which $\sigma_N / \sigma_y > 0.8$ were found in Ref. 54.

Invalid surface flawed data were found in Ref. 53. In addition, Refs. 2 and 53 both contained tests investigating the effect of proof overloading on subsequent testing. Testing in Ref. 16 was just commencing at the time of publication of this report; therefore, only tensile data were available from this reference. Testing to be conducted in Ref. 16 will include cyclic tests with and without prior proof overloading. Ref. 38 contains useful data for surface flaws emanating from holes.

Most of the references cited in the main body of this report contained some invalid fracture data in addition to the valid data that was reported.

APPENDIX C

CONVERSION OF U.S. CUSTOMARY UNITS TO SI UNITS

Due to the complexity of the data presented in this report, only U.S. customary units are used. Conversion factors for converting U.S. customary to SI units are given in the following table:

To Convert From	Multiply	To Obtain	
(U.S. Customary Unit)	by	(SI Units)	
in.	2.54×10^{-2}	meter (m)	
lbf	4.448	newton (n)	
kip	4.448	kilonewton (kN)	
ksi	6.895	meganewton/meter ² (MN/m ²)	
ksi√in	1.099	$MN/m^{3/2}$	

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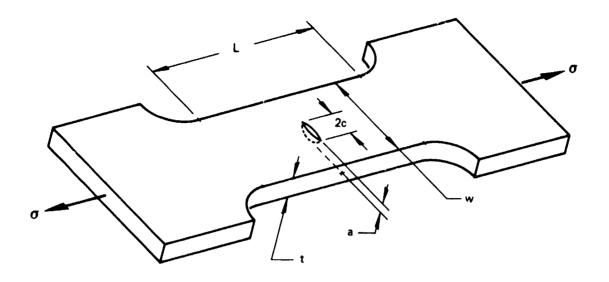


Figure 1: Surface Flaw Specimen Configuration

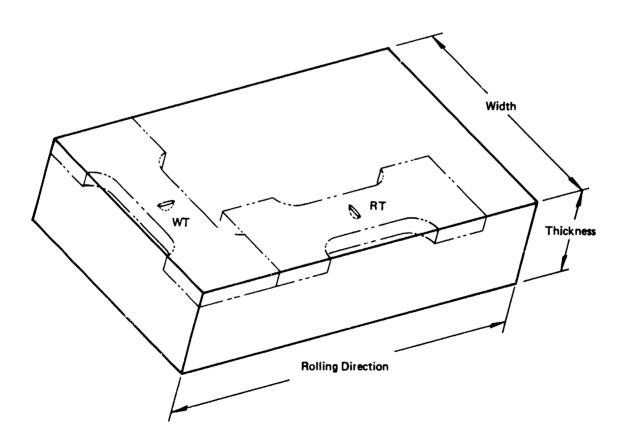


Figure 2: Propagation Direction Code For Surface Flaw Specimens

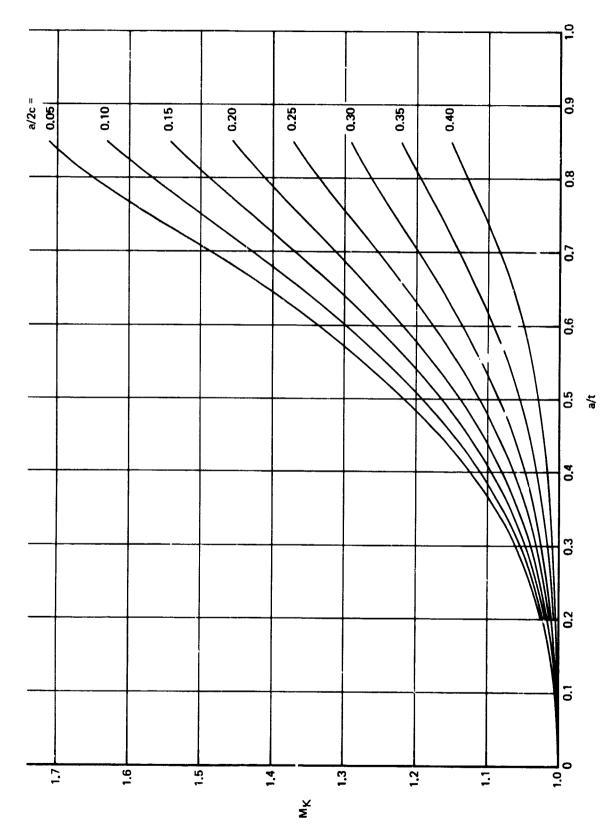


Figure 3: Deep Flaw Magnification Curves (Reference 3)

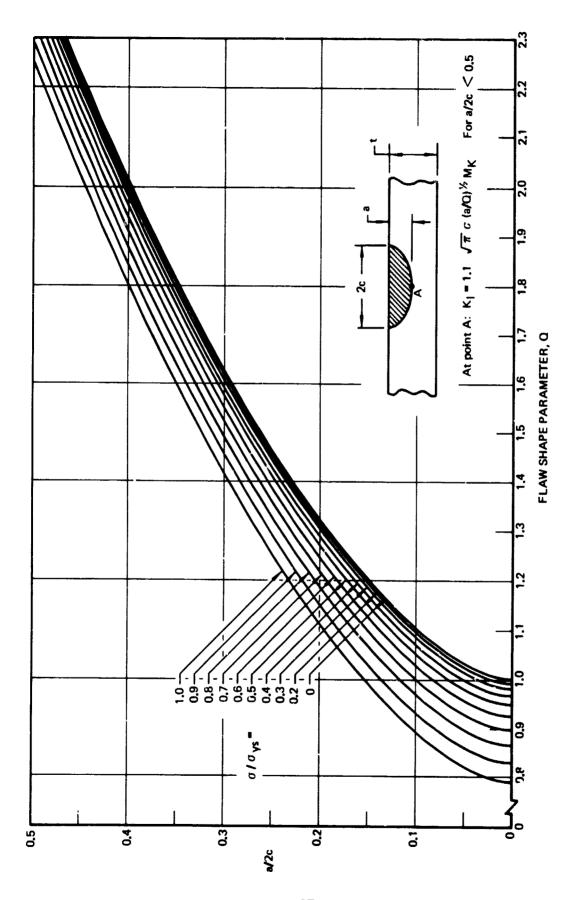


Figure 4 : Shape Parameter Curves for Surface and Internal Flaws

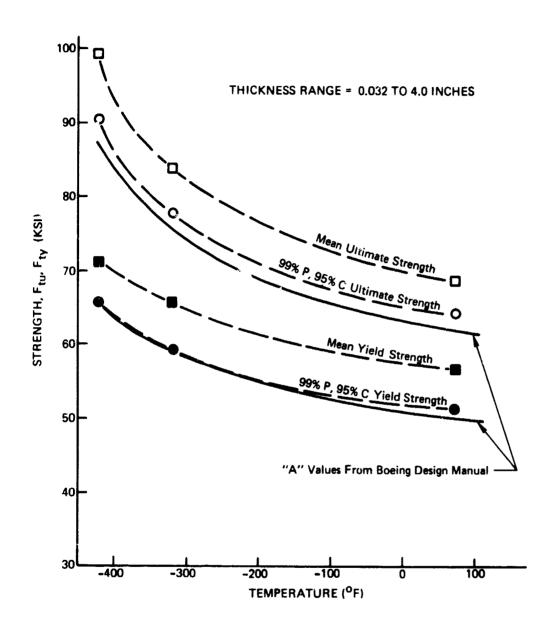


Figure 5: Ultimate and Yield Strength Vs. Temperature, 2219–T87 Aluminum Alloy, Longitudinal Grain Direction

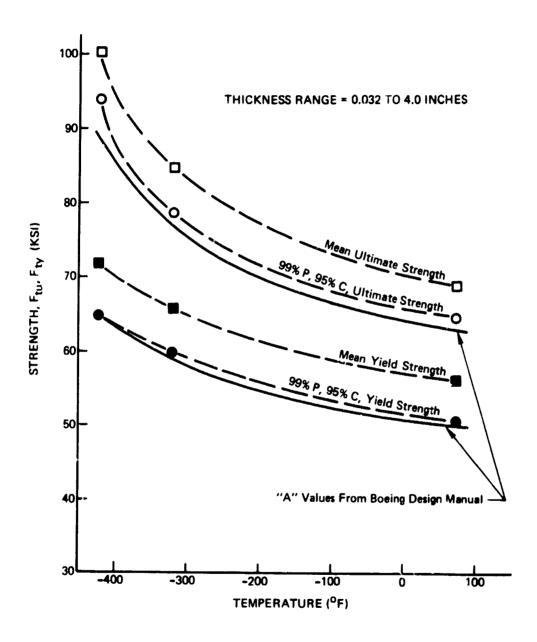


Figure 6: Ultimate and Yield Strength Vs. Temperature, 2219–T87 Aluminum Alloy, Long Transverse Direction

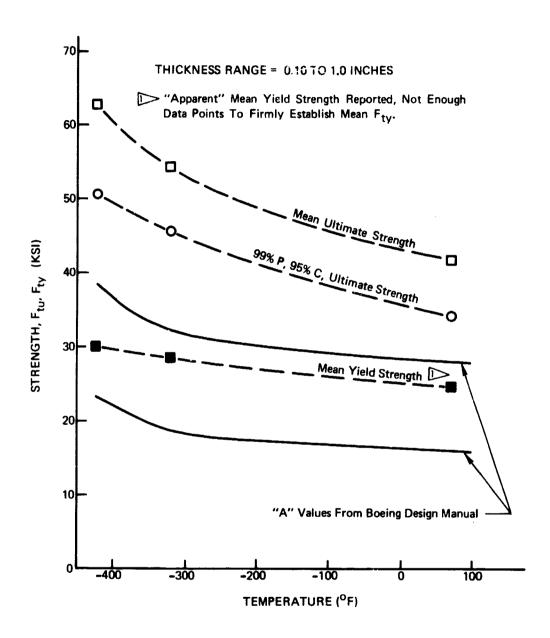


Figure 7: Ultimate and Yield Strength Vs. Temperature, GTA Welded 2219-T87 Aluminum Alloy, No Post Weld Heat Treatment

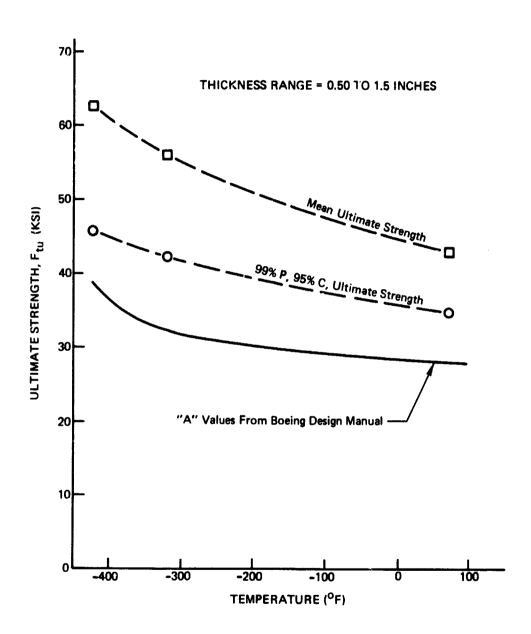


Figure 8: Ultimate Strength Vs. Temperature , GMA Welded 2219-T87 Aluminum Alloy, No Post Weld Heat Treatment

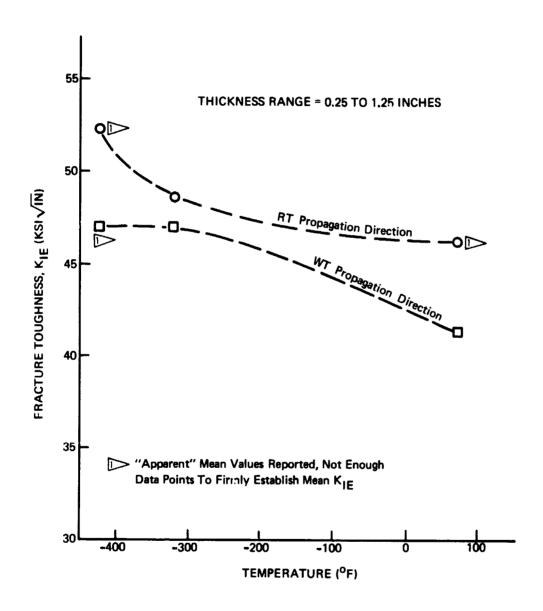


Figure 9: Fracture Toughness Vs. Temperature, 2219-T87 Aluminum Alloy, RT and WT Propagation Direction (From Surface Flawed Specimen Tests)

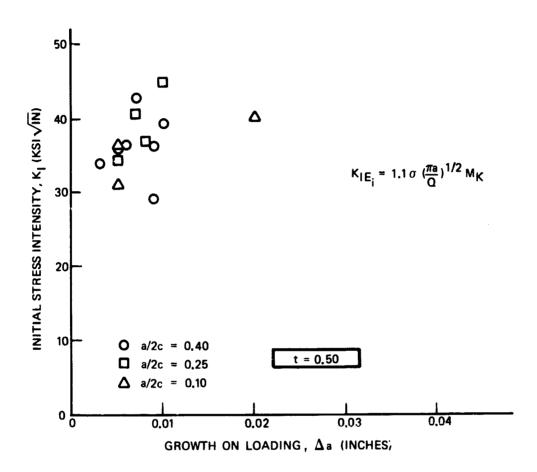


Figure 10: Growth-On-Loading in 2219-T87 Aluminum Base Metal in Liquid Nitrogen at -320°F (surface flawed specimens)

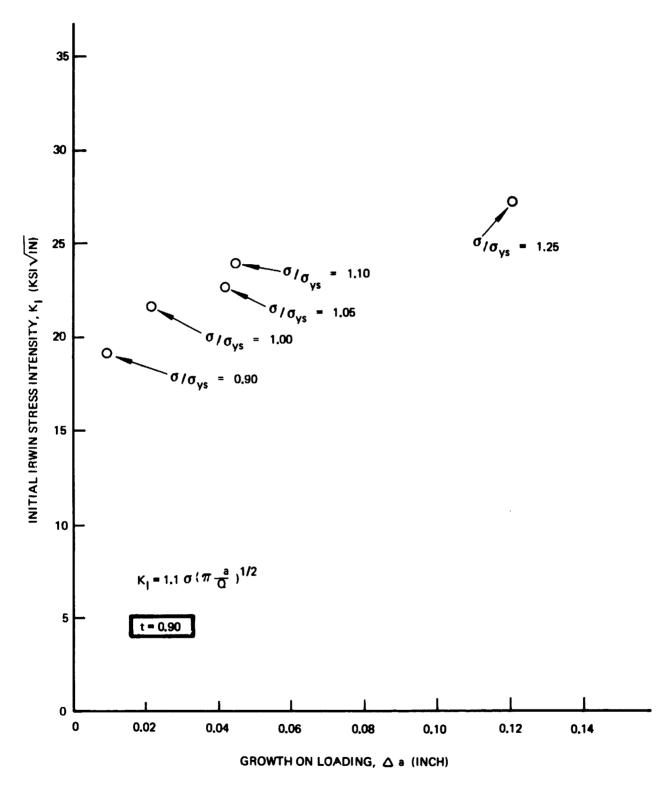


Figure 11: Growth-On-Loading In 2219-T87 Aluminum GTA Weldment In Air At Room Temperature, No Post Weld Heat Treatment (Surface Flawed Specimens)

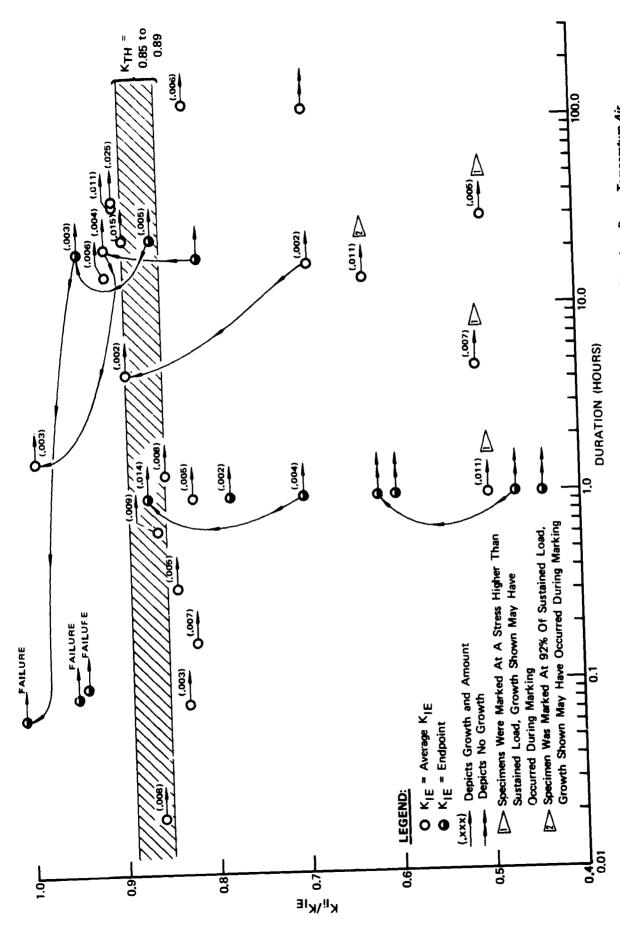


Figure 12: Stress Intensity Vs. Test Duration, 2219-T87 Aluminum Alloy, WT Propagation Direction, Room Temperature Air, t=0.65 Inches (Reference 14)

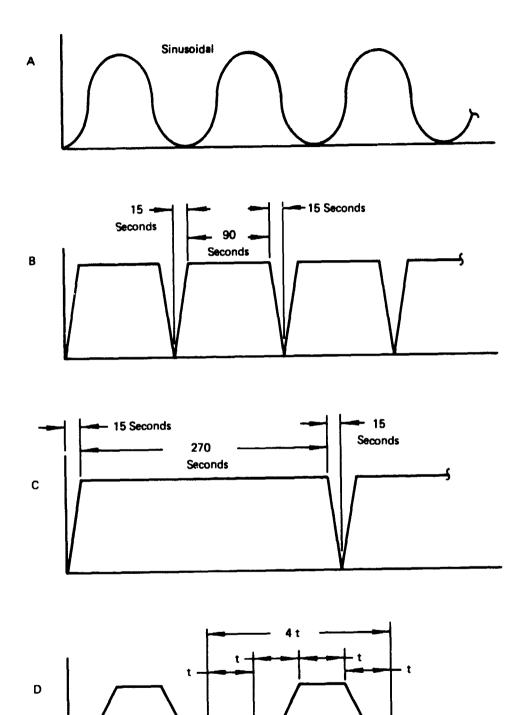


Figure 13: Cyclic Loading Profile

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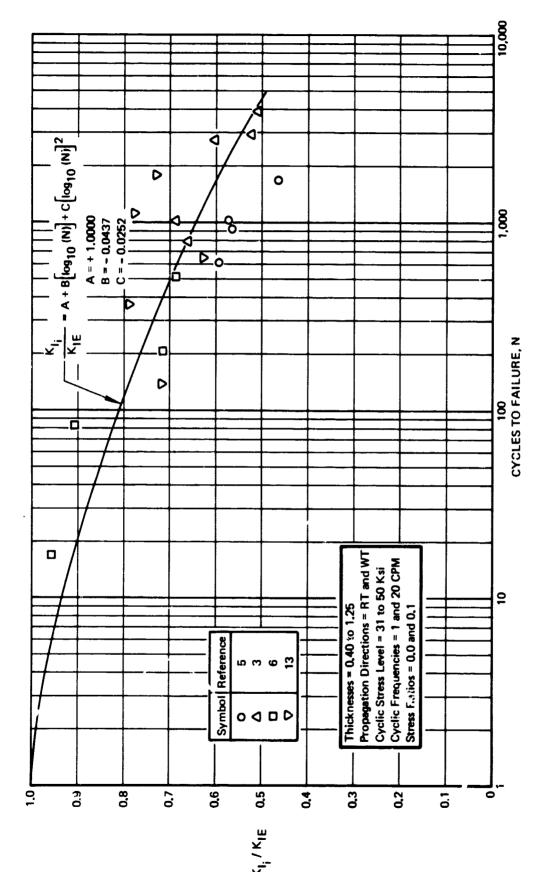


Figure 14: Initial Stress Intensity Vs. Cycles to Failure, 2219-T87 Aluminum Alloy Tested at Room Temperature in Air

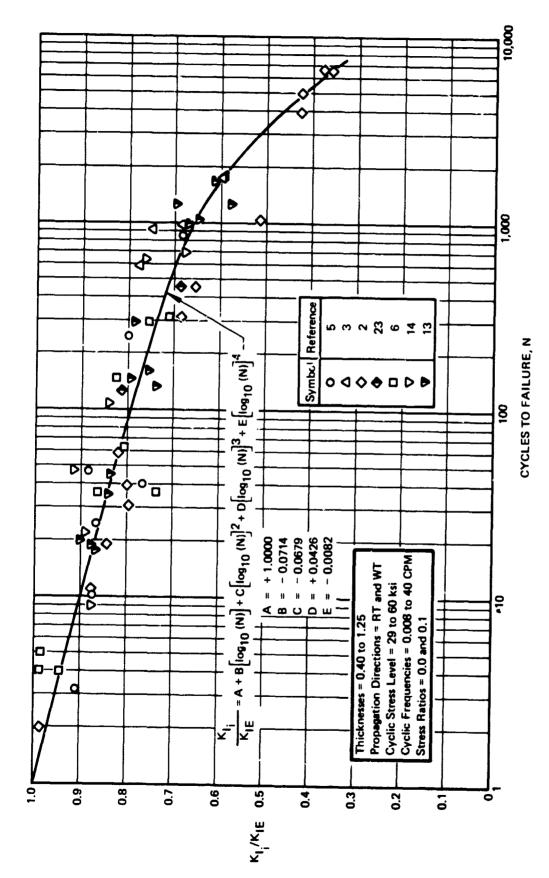


Figure 15: Initial Stress Intensity Vs. Cycles to Failure, 2219-T87 Aluminum Alloy Tested at -320^{o} F in Liquid Nitrogen

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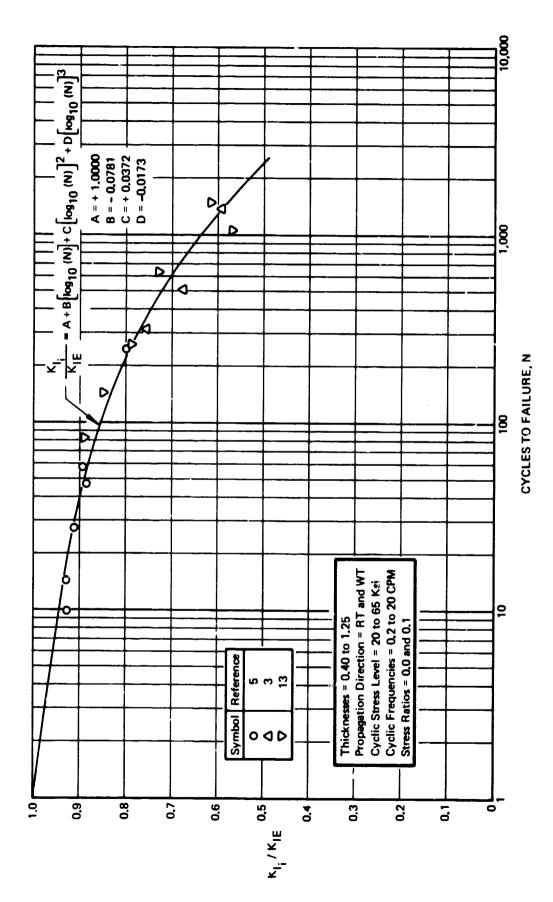


Figure 16:Initial Stress Intensity Vs. Cycles to Failure , 2219—187 Aluminum Alloy Tested at -423ºF in Liquid Hydrogen

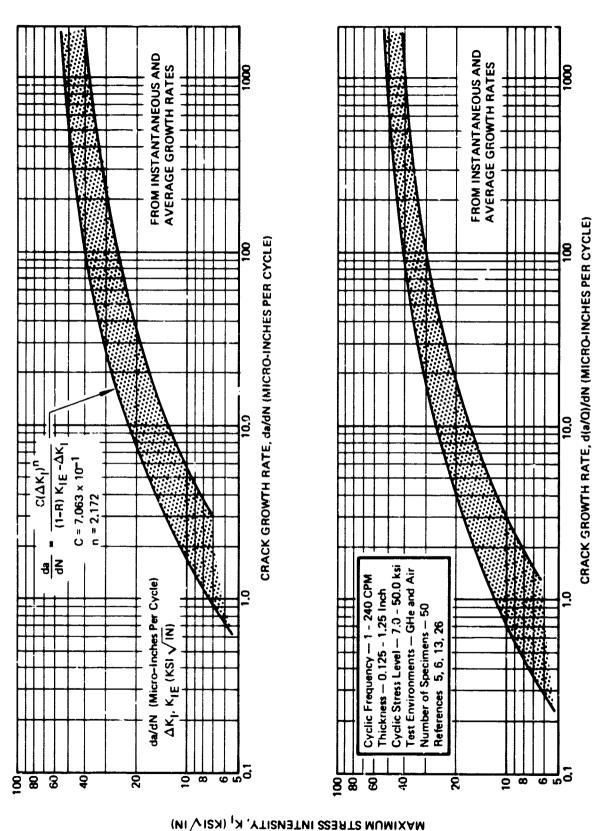


Figure 17 : Cyclic Flaw Growth Rates For 2219-T37 Aluminum Base Metal At Room Temperature For The WT Propagation Direction ,

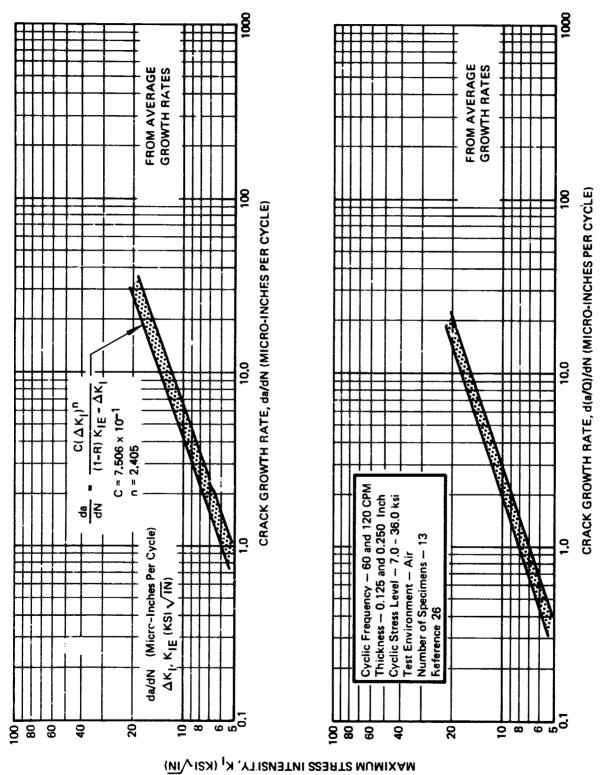


Figure 18 : Cyclic Flaw Growth Rates For 2219-T87 Aluminum Base Metal At Room Temperature For The RT Propagation Direction , $R \le 0.1$

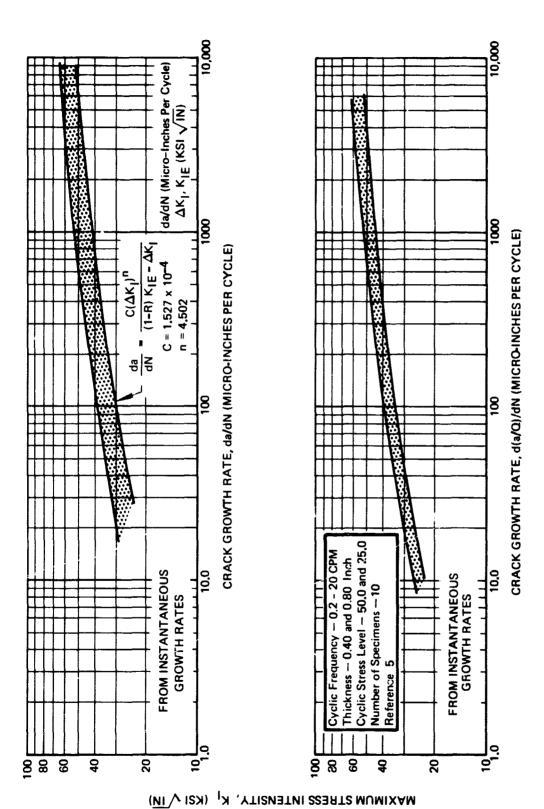


Figure 19 : Cyclic Flaw Growth Rates for 2219-T87 Aluminum Base Metal At Room Temperature in a 31% NaCl Environment for the WT Propagation Direction ,R ≤ 0 .1

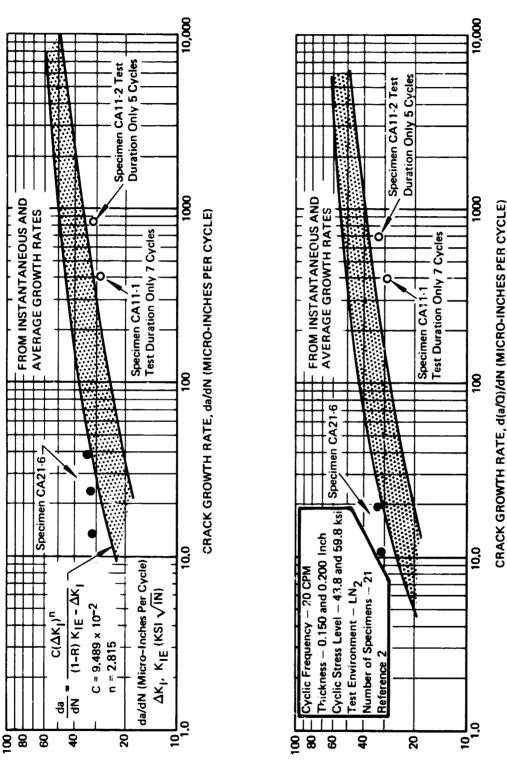


Figure 20 : Cyclic Flaw Growth Rates For 2219-T87 Aluminum Base Metal At -320 o F For The WT Propagation Direction ,R \leq 0.1

MAXIMUM STRESS INTENSITY, K₁ (KSI $\sqrt{1N}$)

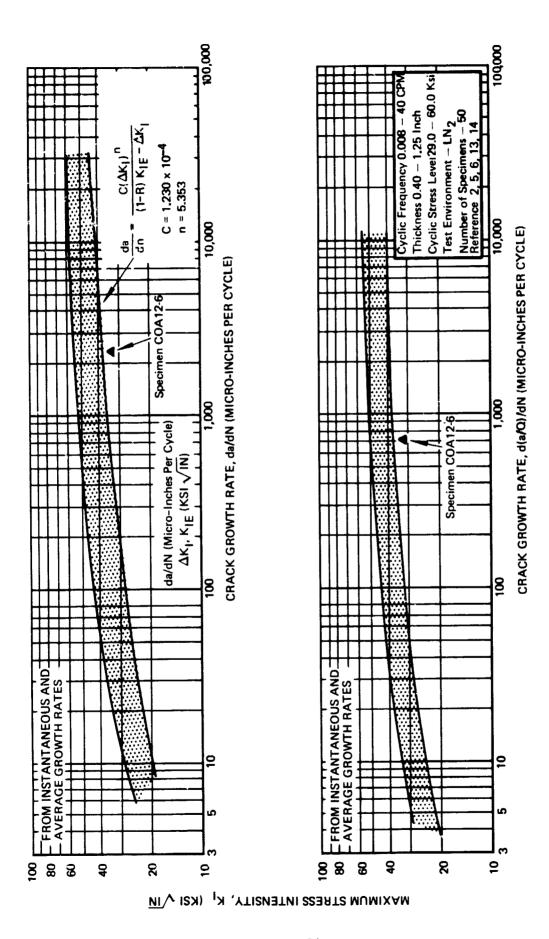


Figure 21 : Cyclic Flaw Growth Rates For 2219-T87 Aluminum Base Metal At -320^{0} F For The WT Propagation Direction ,R ≤ 0.1

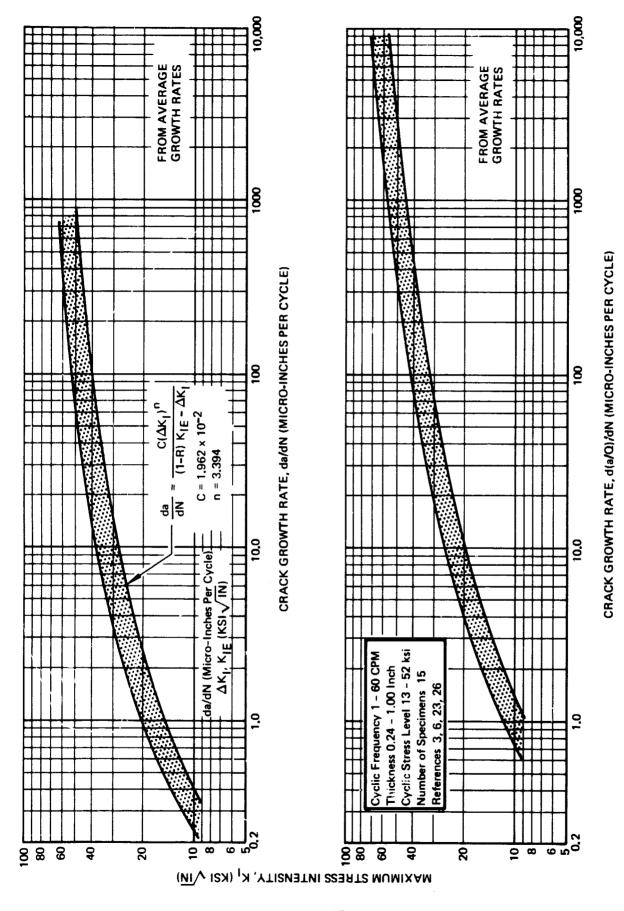
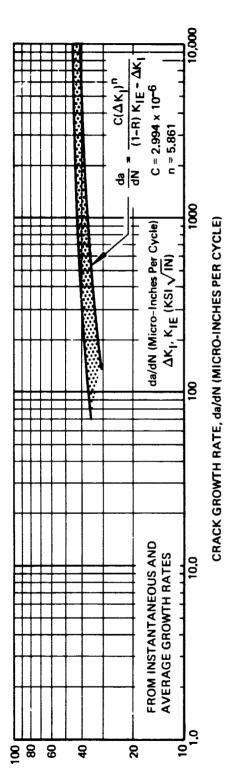


Figure 22 : Cyclic Flaw Growth Rates For 2219-T87 Aluminum Base Metal At -320 0 F For The RT Propagation Direction ,R \leq 0.1



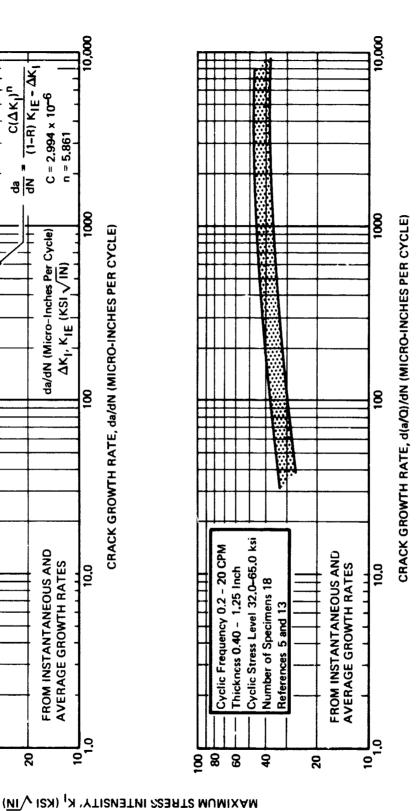


Figure 23 : Cyclic Flaw Growth Rates For 2219-T87 Aluminum Base Metal At 4230 F For The WT Propagation Direction, $R \le 0.1$

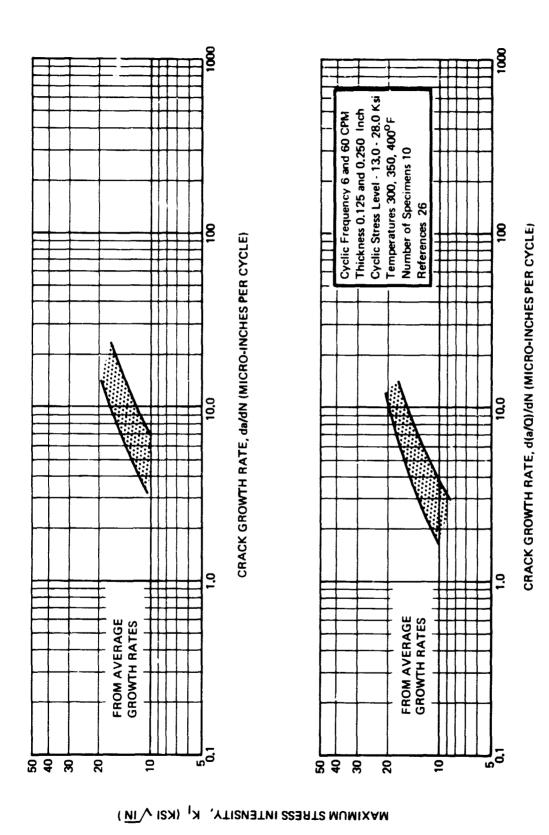
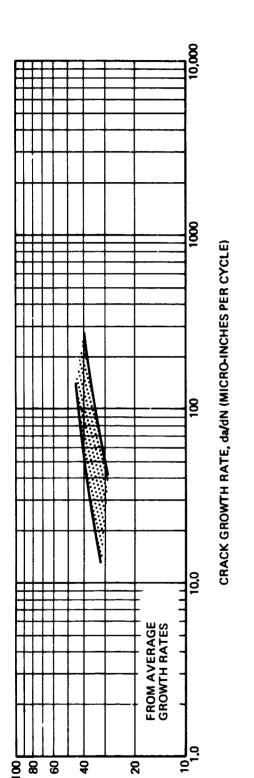


Figure 24 : Cyclic Flaw Growth Rates For 2219-T87 Aluminum Base At Elevated Temperatures For The WT And RT Propagation Direction, R < 0.1



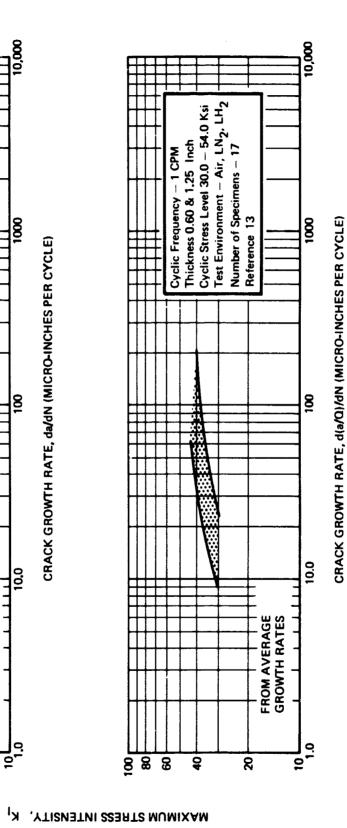


Figure 25:Cyclic Flaw Growth Rates For 2219-T87 Aluminum Base Metal at Room Temperature , -320°F And -4230F For The WT Propagation Direction, R = 0.5

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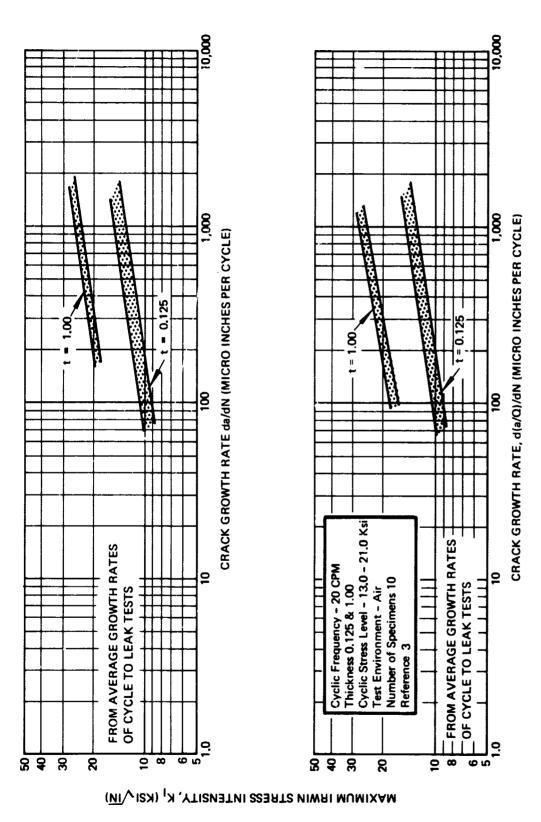


Figure 26: Cyclic Flaw Growth Rates for 2219 Aluminum Alloy Weldments at 72 ^{o}F , $R \le 0.1$

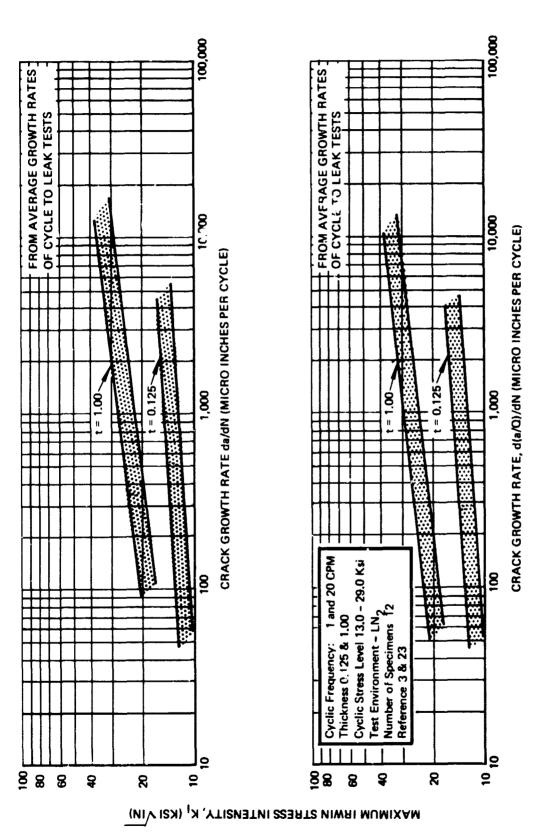


Figure 27: Cyclic Flow Growth Rates For 2219 Aluminum Weldments at -320°F , $R \le 0.1$

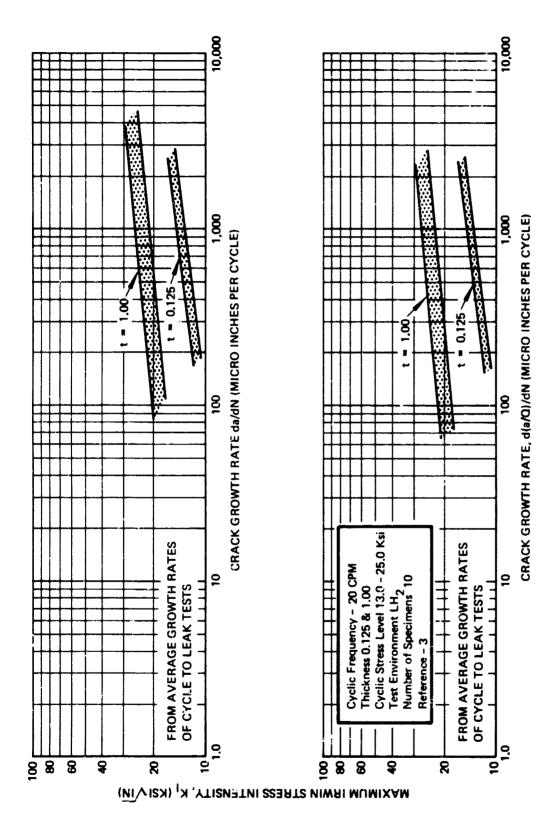


Figure 28: Cyclic Flaw Growth Rates for 2219 Aluminum Weldments at $-423^0 F$, $R \le 0.1$

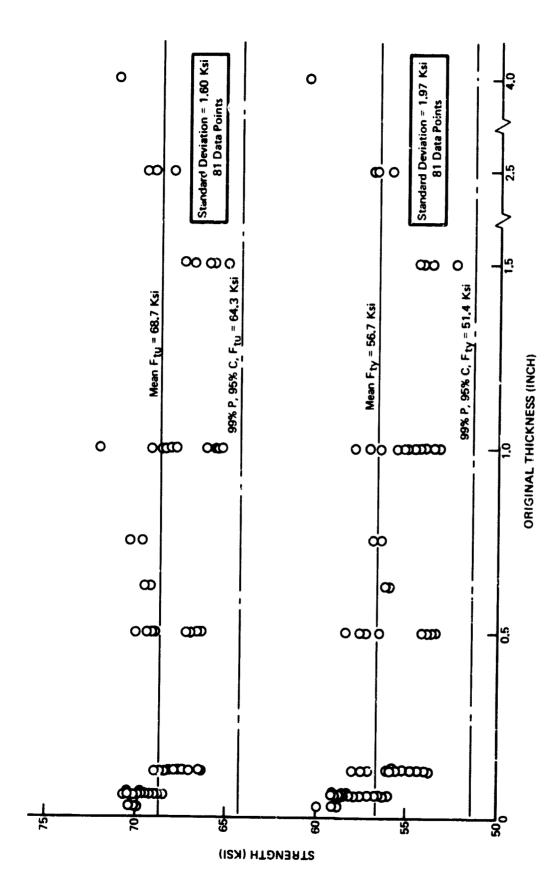


Figure 29: Room Temperature (70°F - 75°F) Yield Strength and Ultimate Strength Vs. Thickness for 2219–787 Aluminum Alloy, Longitudinal Grain

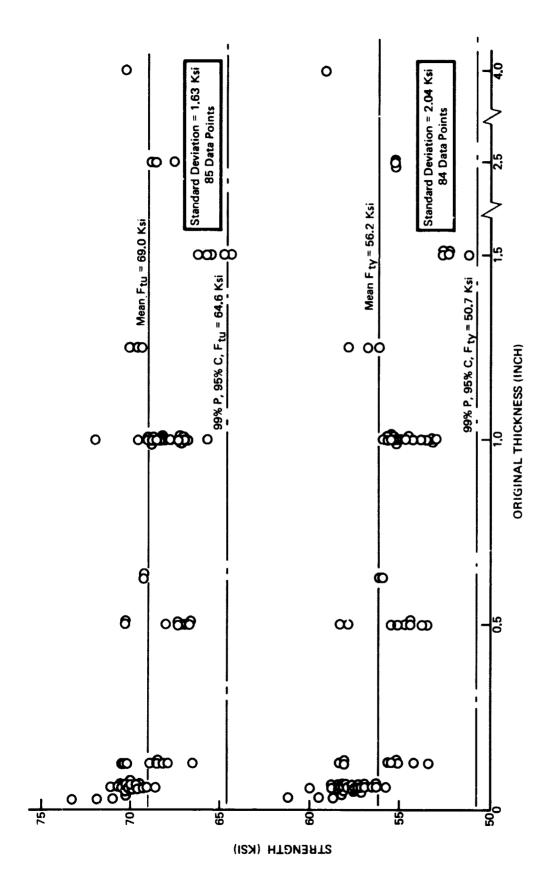


Figure 30: Room Temperature (70º F - 75º F) Yield Strength and Ultimate Strength Vs. Thickness for 2219-T87 Aluminum Alloy Long Transverse Grain

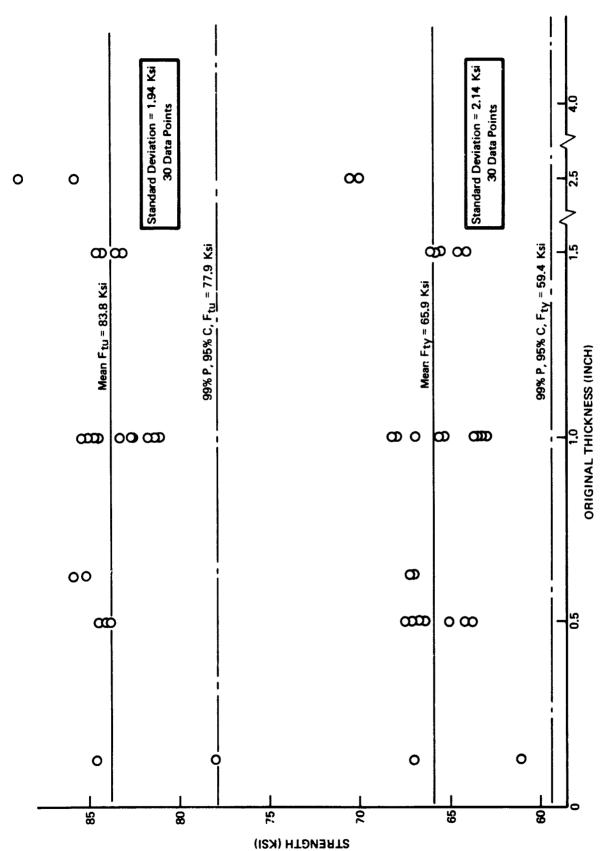


Figure 31: Liquid Nitrogen Temperature (-320⁰ F) Yield Strength and Ultimate Strength Vs. Thickness for 2219-T87 Aluminum Alloy Longitudinal Grain

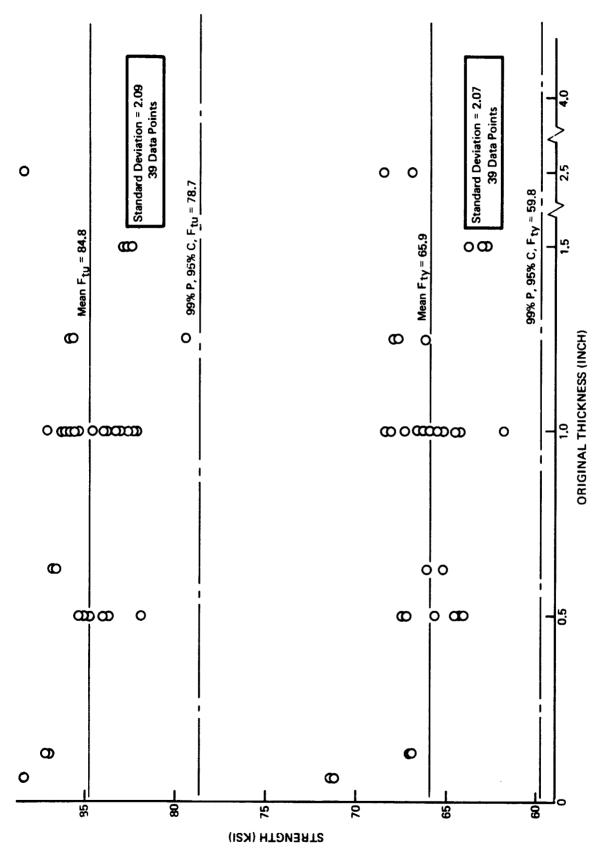


Figure 32: Liquid Nitrogen Temperature (-320°F) Yield Strength and Ultimate Strength Vs. Thickness for 2219-T87 Aluminum Alloy Long Transverse Grain

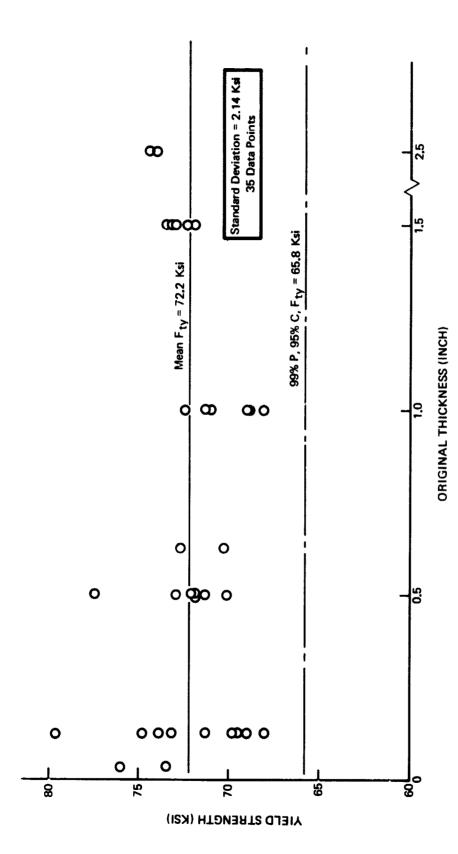


Figure 33: Liquid Hydrogen Temperature (-423⁰F) Yield Strength Vs. Thickness for 2219-T87 Aluminum Alloy Longitudinal Grain

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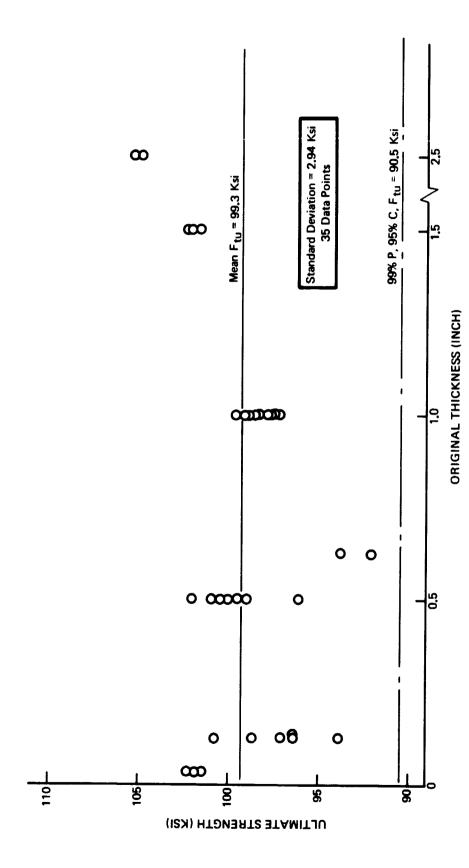


Figure 34: Liquid Hydrogen Temperature (-423^oF) Ultimate Strength Vs. Thickness for 2219-T87 Aluminum Alloy Longitudinal Grain

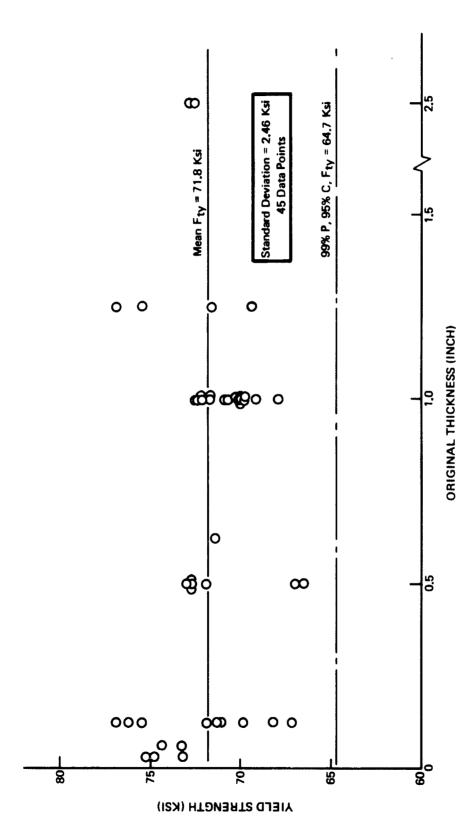


Figure 35: Liquid Hydrogen Temperature (-423⁰F) Yield Strength Vs. Thickness for 2219-TB7 Aluminum Alloy Long Transverse Grain

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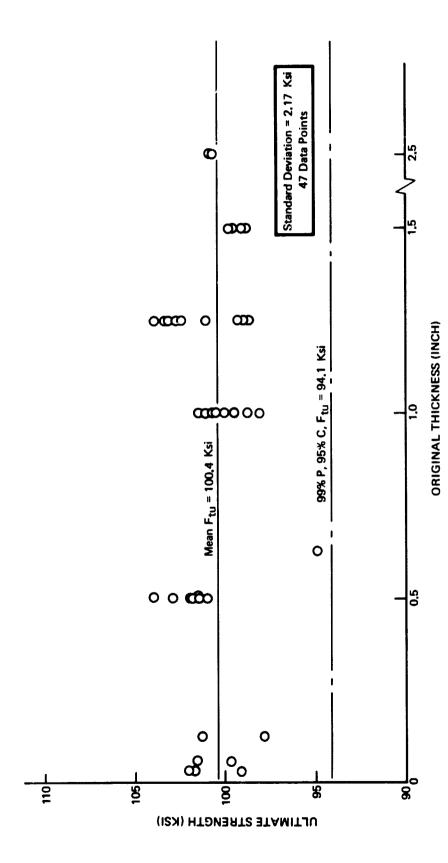


Figure 36: Liquid Hydrogen Temperature (-423^oF) Ultimate Strength Vs. Thickness for 2219-T87 Aluminum Alloy Long Transverse Grain

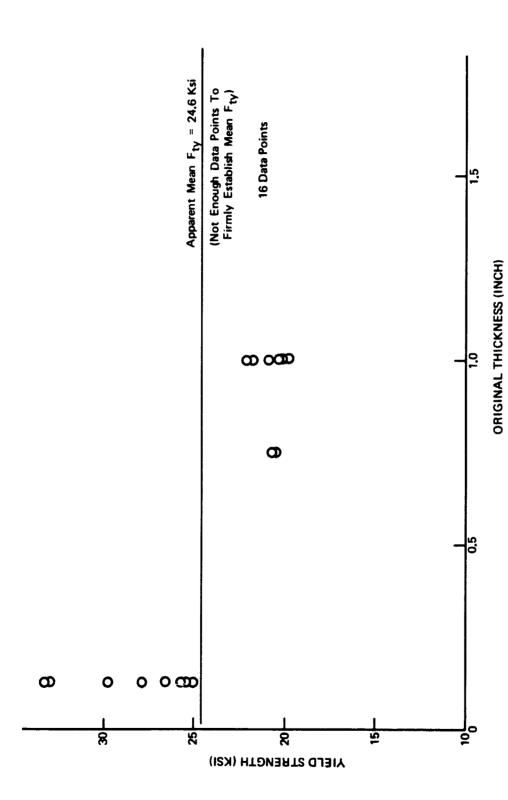


Figure 37: Room Temperature (70° F - 75° F) Yield Stress Vs. Thickness for 2219-T87 Aluminum Alloy GTA Weldments, No Post Weld Heat Treatment

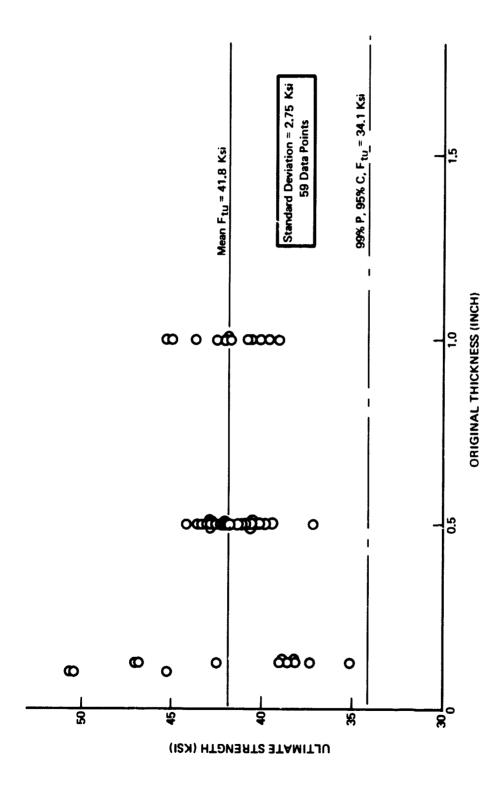


Figure 38: Room Temperature (70 $^{\circ}F$ – 75 $^{\circ}F$) Ultimate Strength Vs. Thickness for 2219–787 Aluminum Alloy GTA Weldments, No Post Weld Heat Treatment

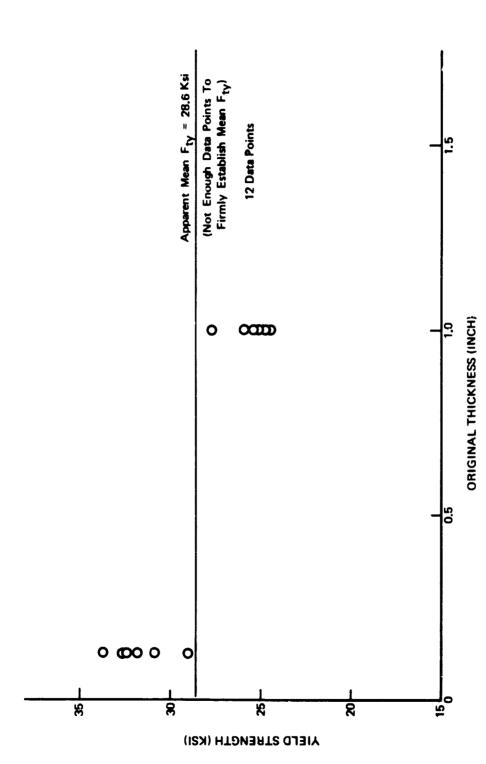


Figure 39: Liquid Nitrogen Temperature (-320^o F) Yield Strength Vs. Thickness for 2219-T87 Aluminum Alloy GTA Weldments, No Post Weld Heat Treatment

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Figure 40: Liquid Nitrogen Temperature (-3200 F) Ultimate Strength Vs. Thickness for 2219-T87 Aluminum Alloy GTA Weldments, No Post Weld Heat Treatment

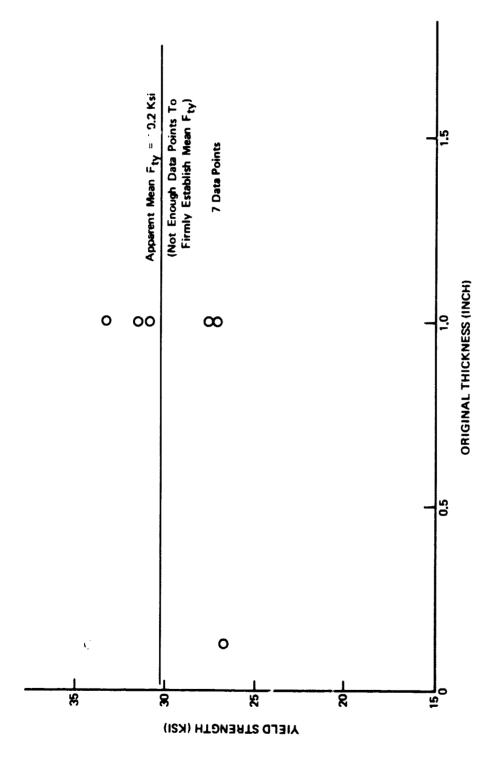


Figure 41: Liquid Hydrogen Temperature (-423°F) Yield Strength Vs. Thickness for 2219-T87 Aluminum Alloy GTA Weldments, No Post Weld Heat Treatment

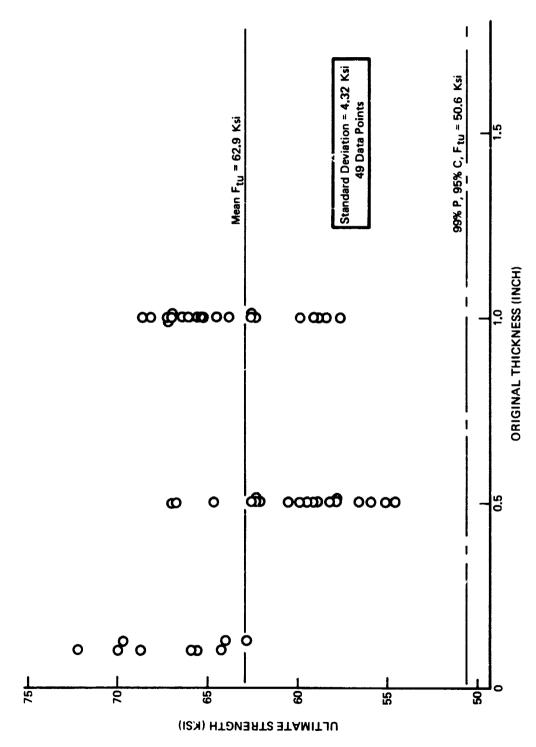


Figure 42: Liquid Hydrogen Temperature (-423^oF) Ultimate Strength Vs. Thickness for 2219-787 Aluminum Alloy GTA Weldments, No Post Weld Heat Treatment

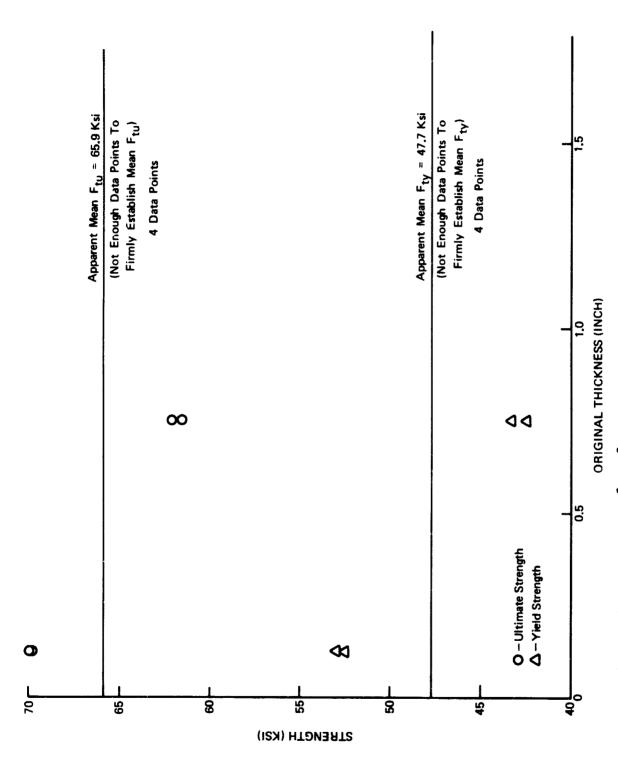


Figure 43: Room Temperature (70 9 F - 75 9 F) Ultimate and Yield Strength Vs. Thickness for 2219-T87 Aluminum Alloy GTA Weldments, Weldments Subjected to STA Thermal Cycle After Welding

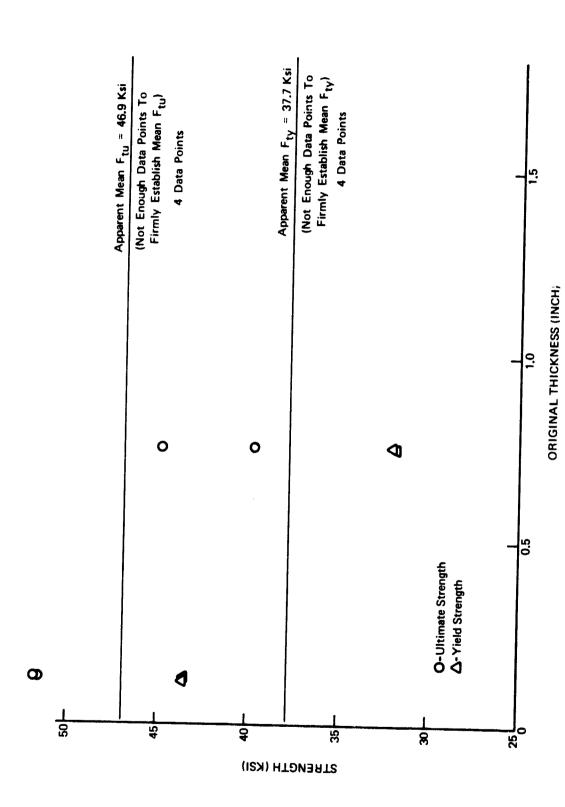


Figure 44: Room Temperature (70 o F - 75 o F) Ultimate and Yield Strength Vs. Thickness for 2219-T87 Aluminum Alloy GTA Weldments, Weldments Aged After Welding

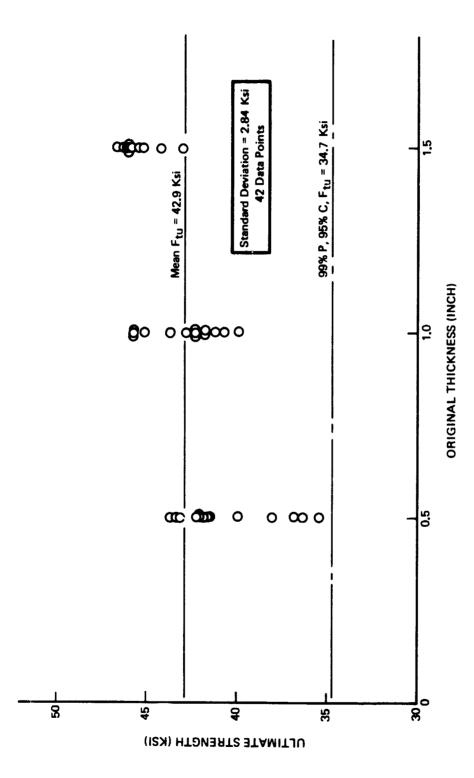


Figure 45: Room Temperature (7 ℓ^0 F - 75°F) Ultimate Strength Vs. Thickness for 2219-TB7 Aluminum Alloy GMA Weldments, No Post Weld Heat Treatment

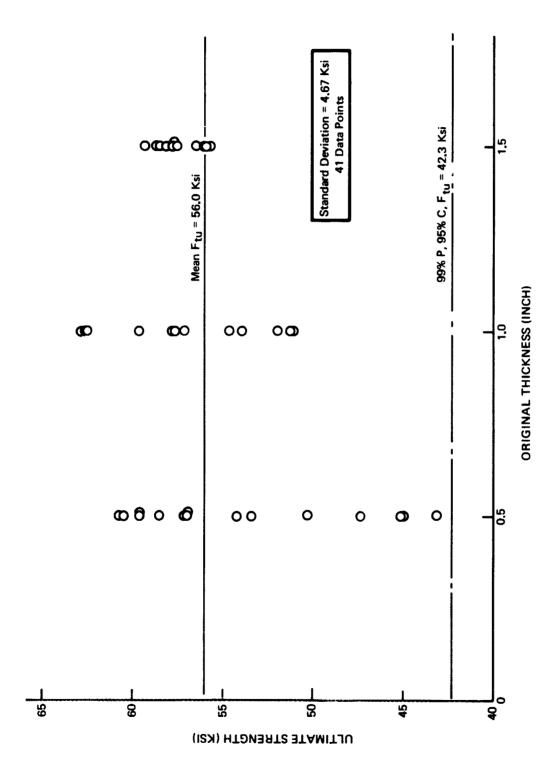


Figure 46: Liquid Nitrogen Temperature (-320⁰F) Ultimate Strength Vs. Thickness for 2219-T87 Aluminum Alloy GMA Weldments, No Post Weld Heat Treatment

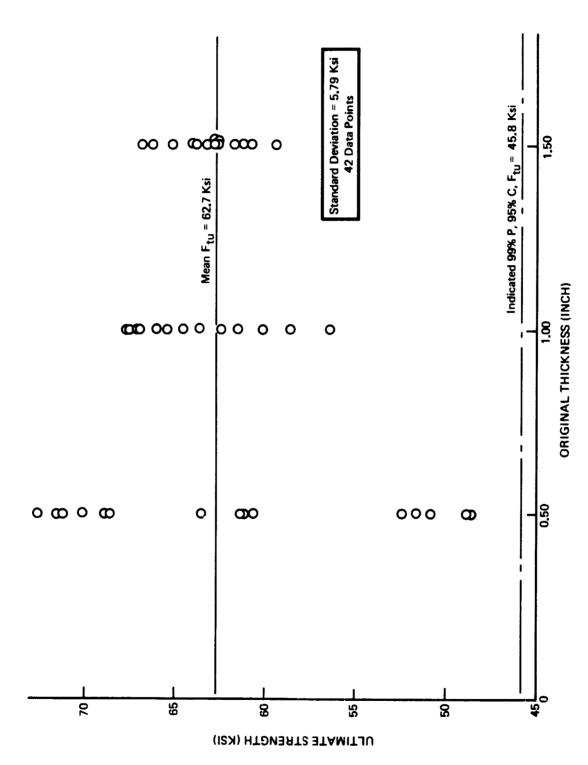


Figure 47: Liquid Hydrogen Temperature (-423 $^{\circ}$ F) Ultimate Strength Vs. Temperature for 2219-787 Aluminum Alloy GMA Weldments, No Post Weld Heat Treatment

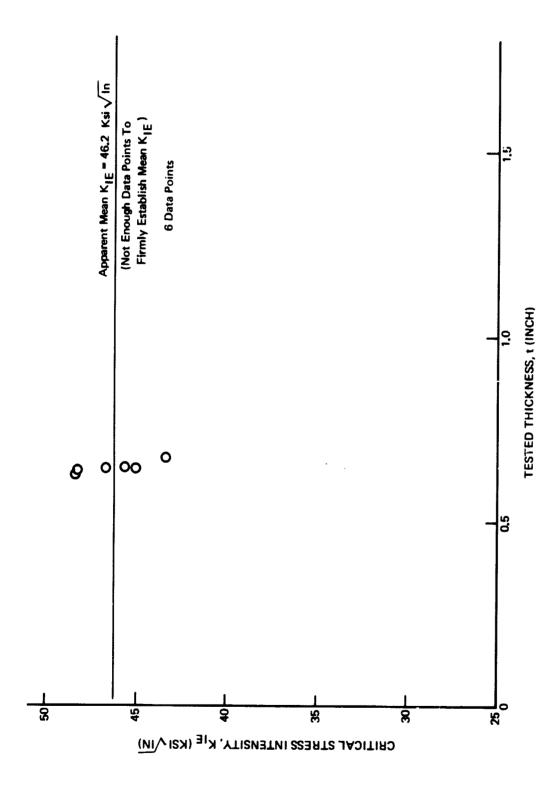


Figure 48: Room Temperature (70 o F - 75 o F) Critical Stress Intensity Vs. Tested Thickness, 2219-T87 Aluminum Alloy, RT Propagation Direction

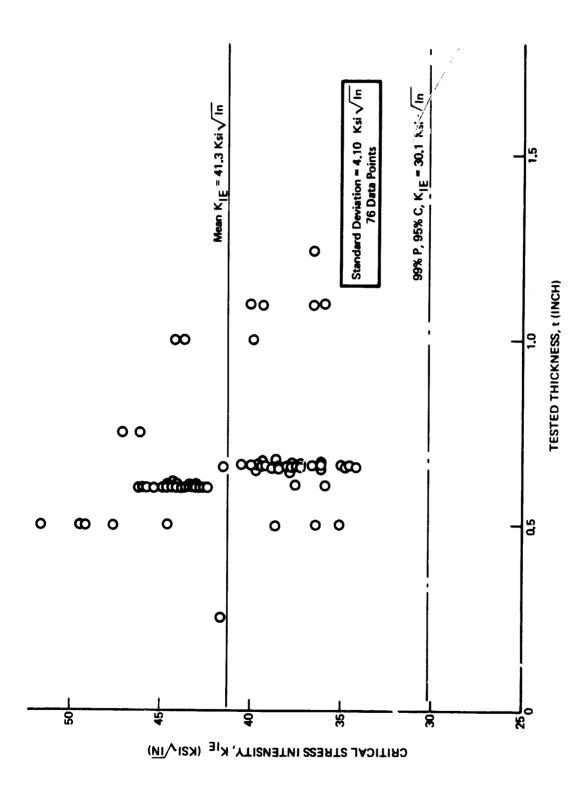


Figure 49: Room Temperature (70° F - 75° F) Critical Stress Intensity Vs. Tested Thickness, 2219-T87 Aluminum Alloy, WT Propagation Direction

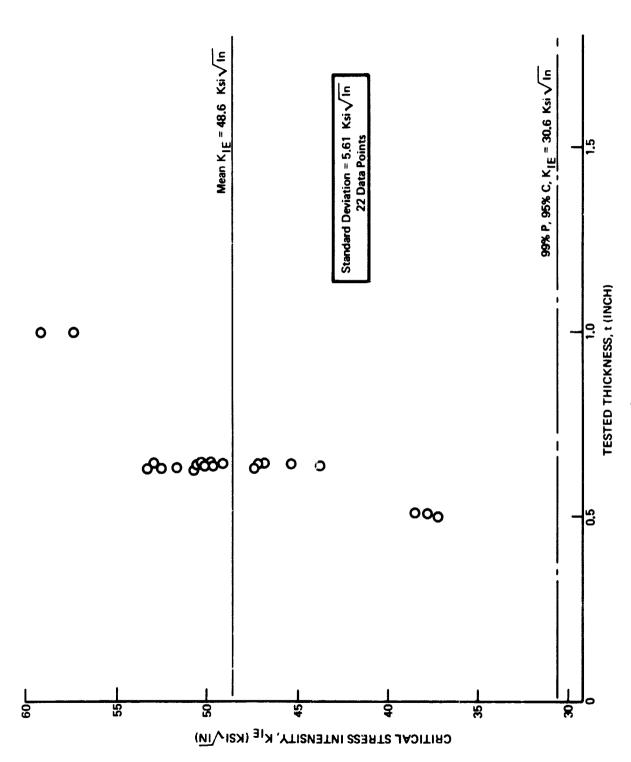


Figure 50: Liquid Nitrogen Temperature (-320°F) Critical Stress Intensity Vs. Tested Thickness, 2219-T87
Aluminum Alloy, RT Propagation Direction

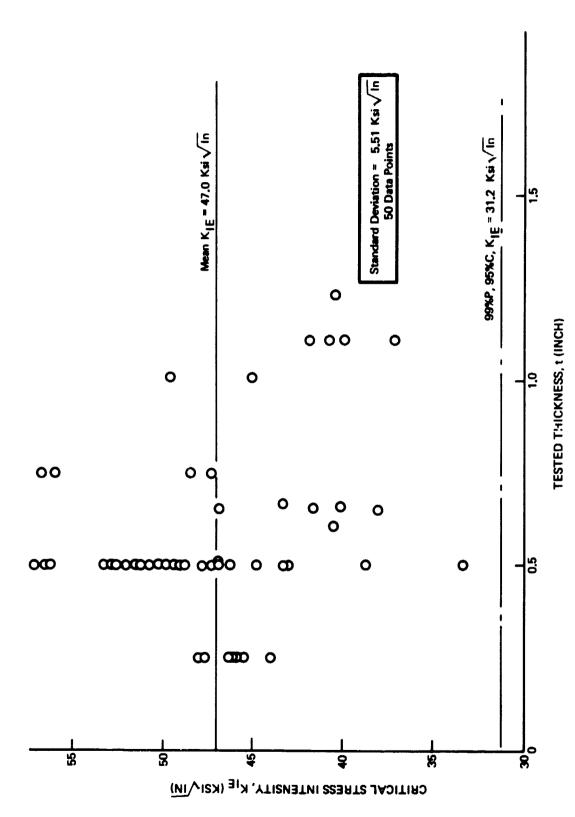


Figure 51: Liquid Nitrogen Temperature (-320°F) Critical Stress Intensity Vs. Tested Thickness, 2219-T87
Aluminum Alloy, WT Propagation Direction

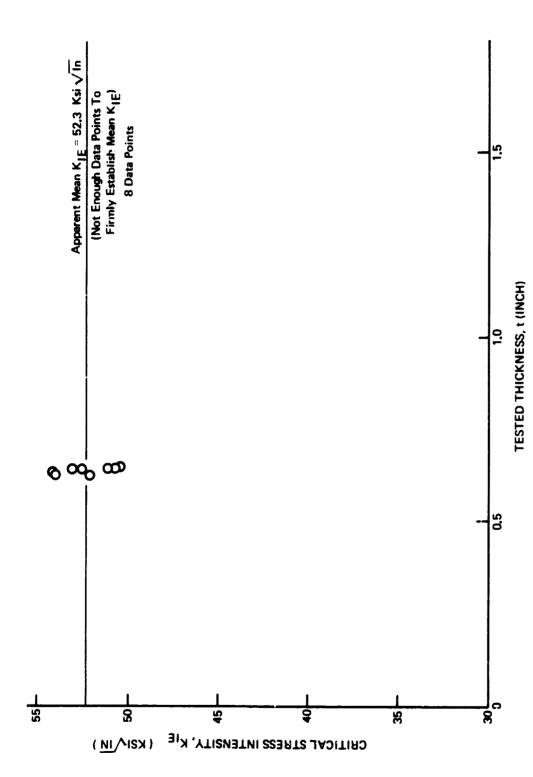


Figure 52: Liquid Hydrogen Temperature (-423⁰F) Critical Stress Intensity Vs. Tested Thickness, 2219-T87 Aluminum Alloy, RT Propagation Direction

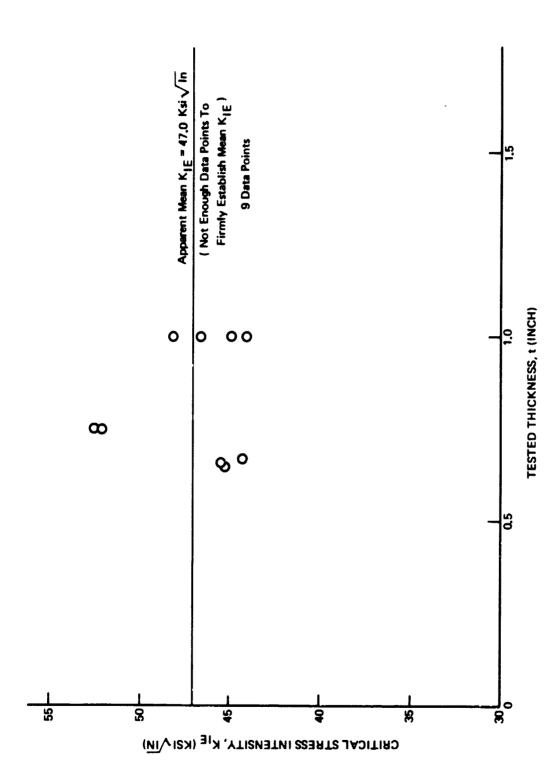


Figure 53: Liquid Hydrogen Temperature (-423°F) Critical Stress Intensity Vs. Tested Thickness, 2219-T87 Aluminum Alloy, WT Propagation Direction

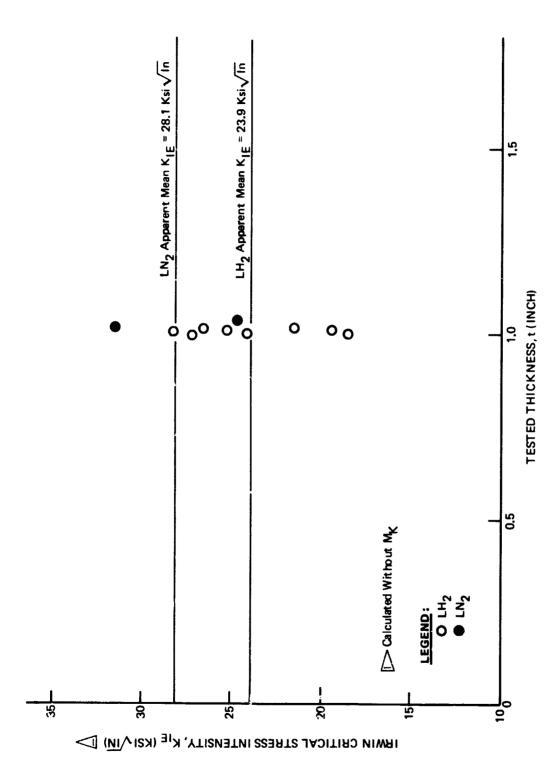


Figure 54: Liquid Nitrogen Temperature (-320°F) and Liquid Hydrogen Temperature (-423°F) Irwin Critical Stress Intensity Vs. Tested Thickness 2219-T87 Aluminum Alloy GTA Weldments, No Post Weld Heat Treatment

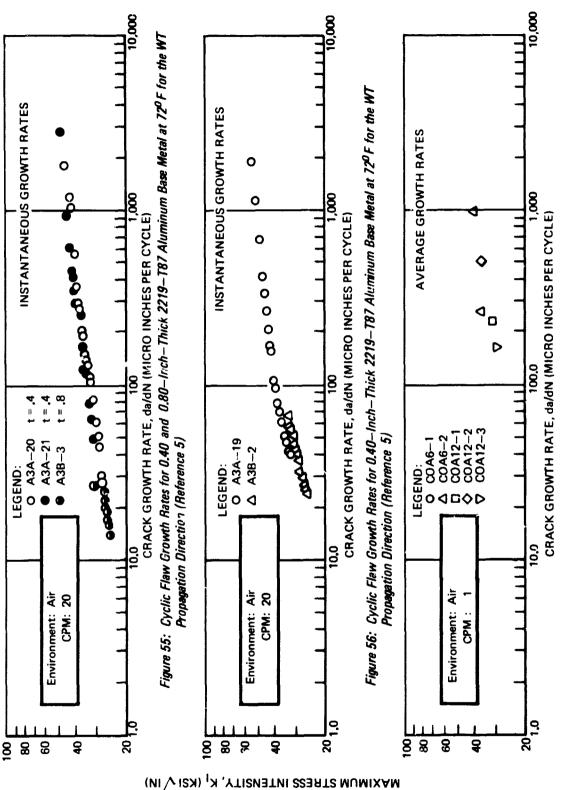


Figure 57: Cyclic Flaw Growth Rates for 0.60 and 1.25—Inch—Thick 2219—T87 Aluminum Base Metal at 72ºF for the WT Propagation Direction (Reference 13)



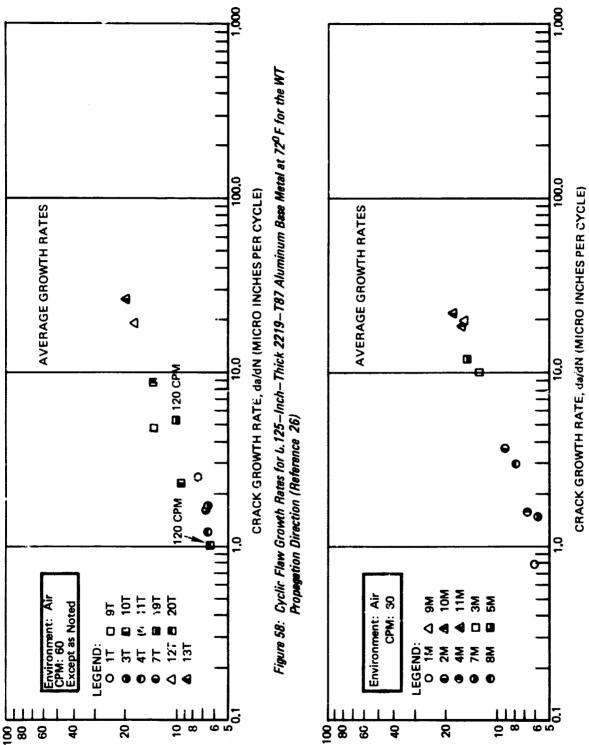


Figure 59: Cyclic Flaw Growth Rates for 0.125—Inch—Thick 2219—T87 Aluminum Base Metal at 72 $^{
m P}$ F for the WT Propagation Direction (Reference 26)

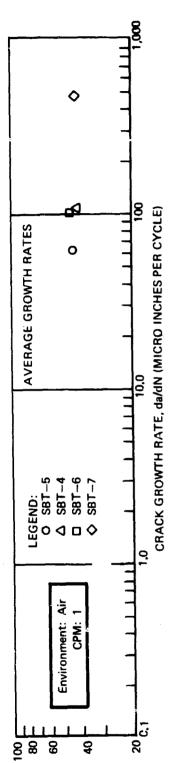


Figure 60: Cyclic Flaw Growth Rates for 1,00—Inch—Thick 2219—T87 Aluminum Base Metal at 72ºF for the WT Propagation Direction (Referen e 6)

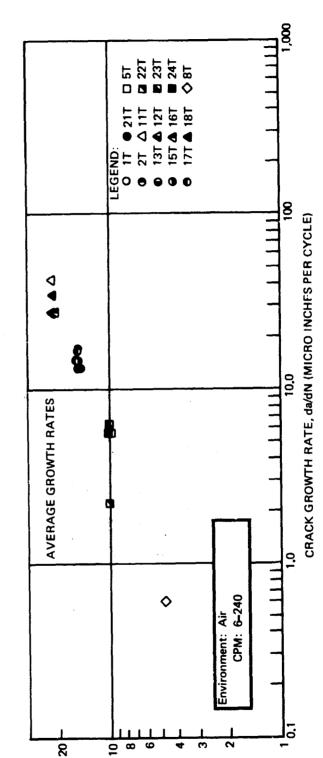


Figure 61: Cyclic Flaw Growth Rates for 0.250-Inch-Thick 2219-187 Aluminum Base Metal at 72ºF for the WT Propagation Direction (Reference 26)

MAXIMUM STRESS INTENSITY, K_{\parallel} (KS! $\sqrt{\parallel M \parallel}$)

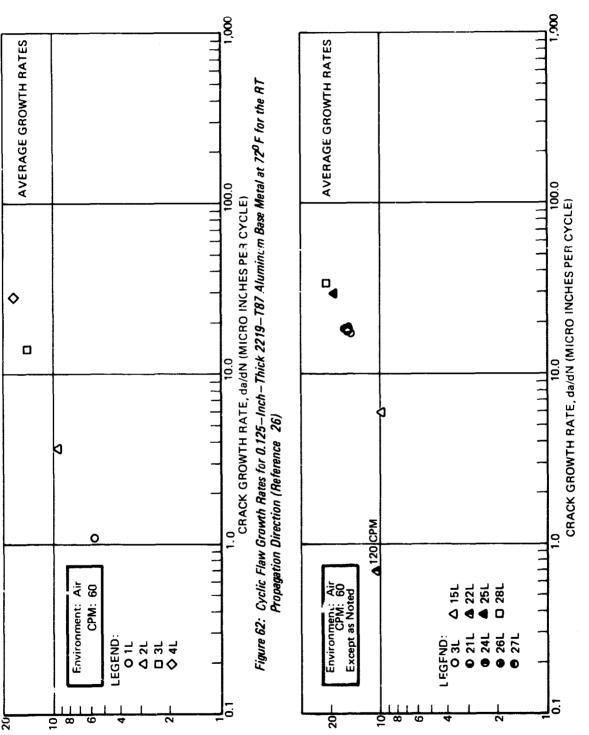


Figure 63: Cyclic Flaw Growth Rates for 0.250—Inch—Thick 2219 -T87 Aluminum Base Metal at 72⁰ F for the RT Propagation Direction (Reference 26)

MAXIMUM STRESS INTENSITY, $\kappa_{\rm I}$ (KS! $\sqrt{\,}$ IN)

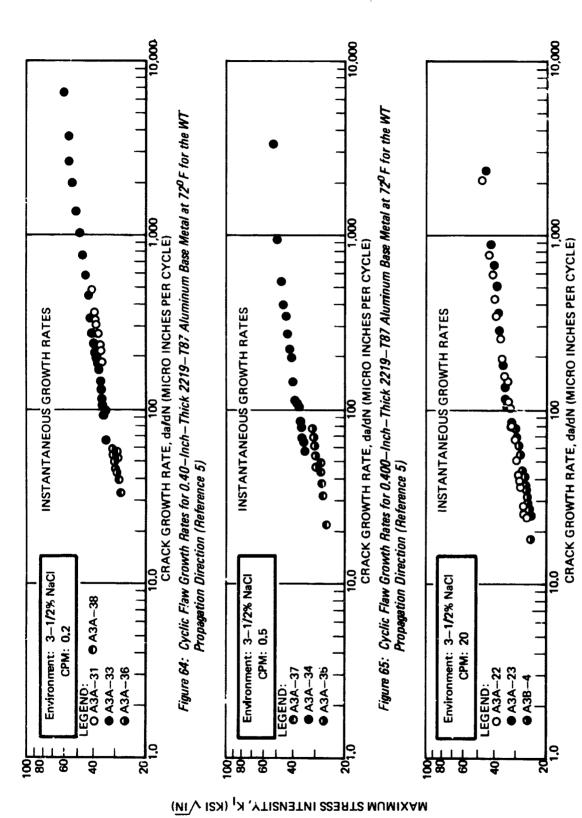
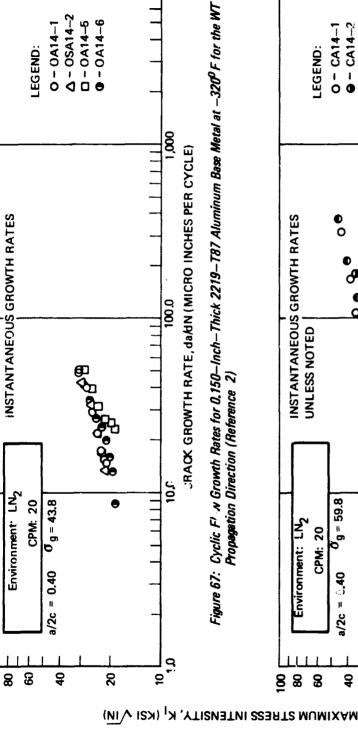


Figure 66: Cyclic Flaw Growth Rates for 0.40 and 0.80—Inch—Thick 2219—787 Aluminum Base Metal at 72º F for the WT Propagation Direction (Reference 5)



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000,1

CRACK GROWTH RATE, daldN (MICRO INCHES PER CYCLE)

100.0

0 - 0A14-5 **0** - 0A14-6 Δ - 0SA14-2

0-0414-1

LEGEND:

INSTANTANEOUS GROWTH RATES

Environment LN2 **CPM: 20** $\sigma_{g} = 43.8$

8

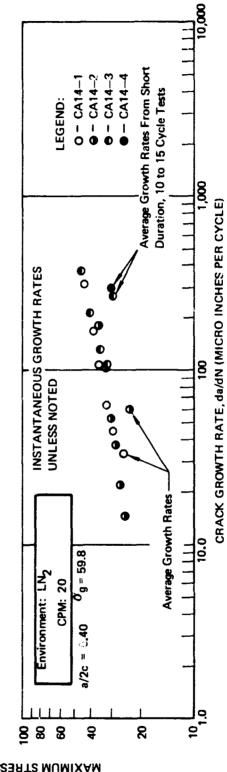


Figure 68: Cyclic Flaw Growth Rates for 0.150–Inch–Thick 2219–T87 Aluminum Base Metal at -320^{o} F for the WT Propagation Direction (Reference 2)

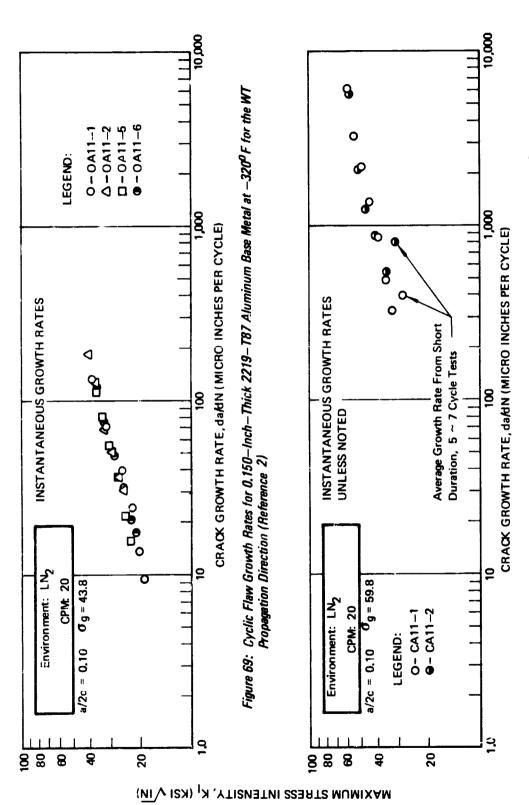


Figure 70: Cyclic Flaw Growth Rates for 0.150-Inch-Thick 2219-T87 Aluminum Base Metal at -320⁰ F for the WT Propagation Direction (Reference 2)

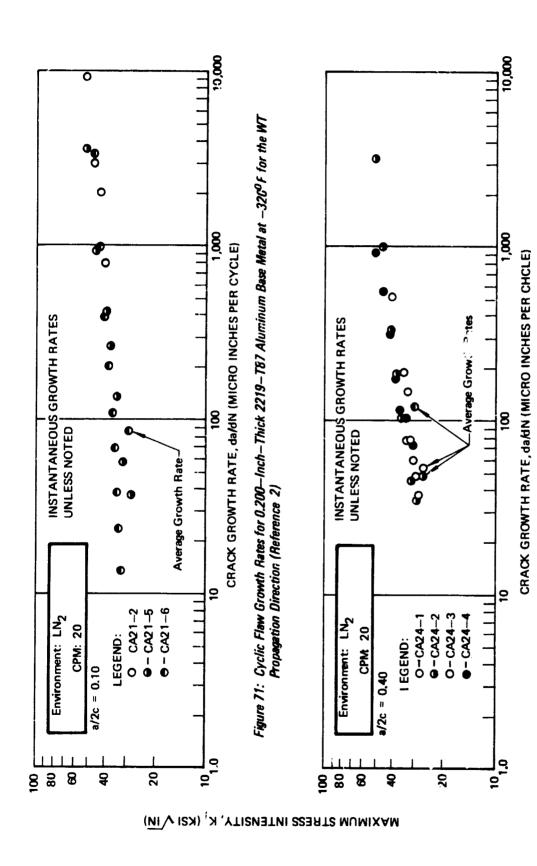


Figure 72: Cyclic Flaw Growth Rates for 0.200—Inch—Thick 2219—T87 Aluminum Base Metal at -3200 F for the WT Propagation Direction (Reference 2)

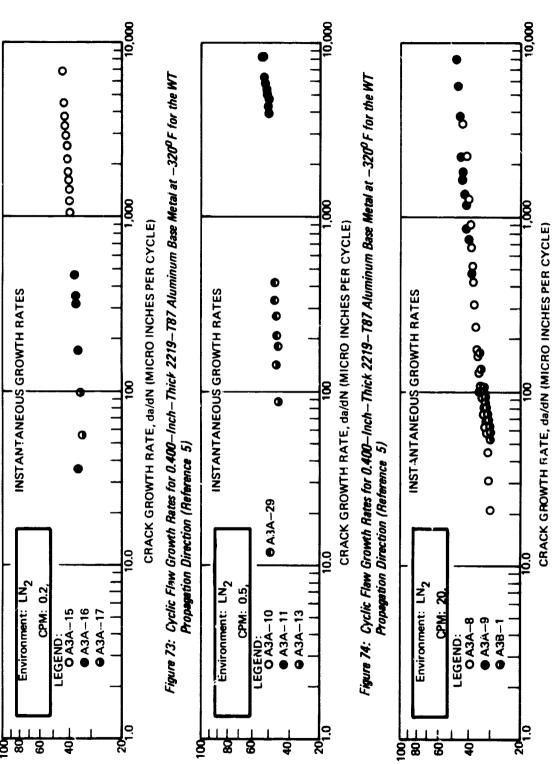


Figure 75: Cyclic Flaw Growth Rates for 0.40 and 0.80—Inch—Thick 2219—T87 Aluminum Base Metal at $-320^{\!0}$ F for the WT Propagation Direction (Reference 5)

MAXIMUM STRESS INTENSITY, $\kappa_{\rm I}$

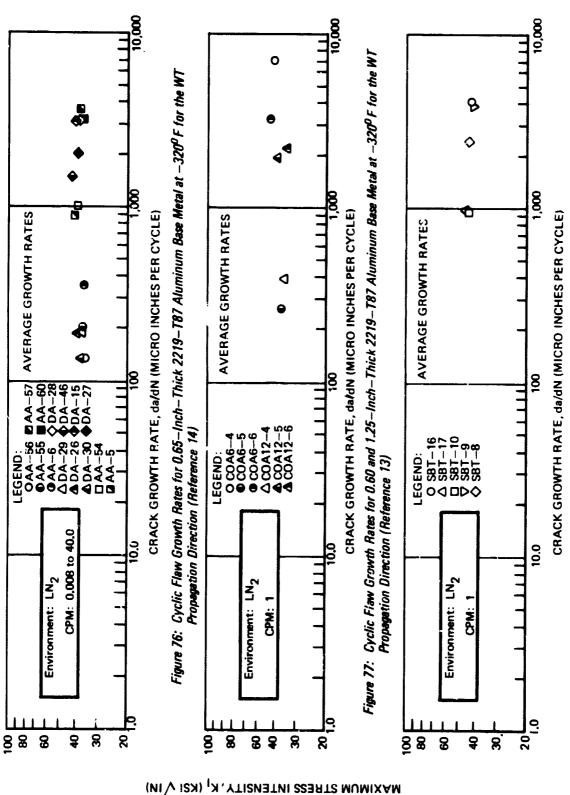
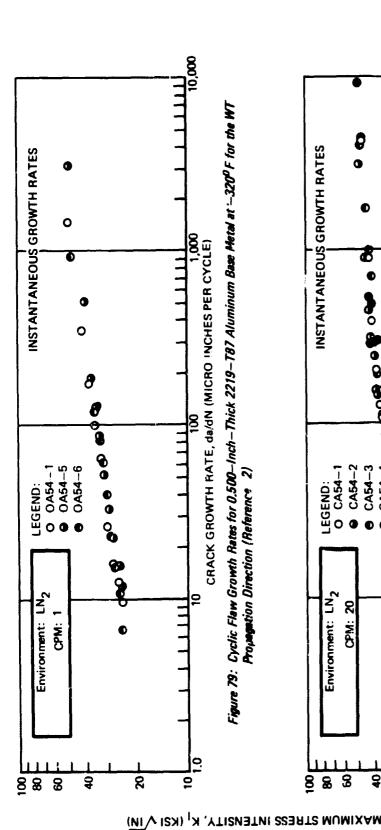


Figure 78: Cyclic Flaw Growth Rates for 1.00—Inch—Thick 2219—T87 Aluminum Base Metal at —3200 F for the WT Propention Direction (Reference 6)



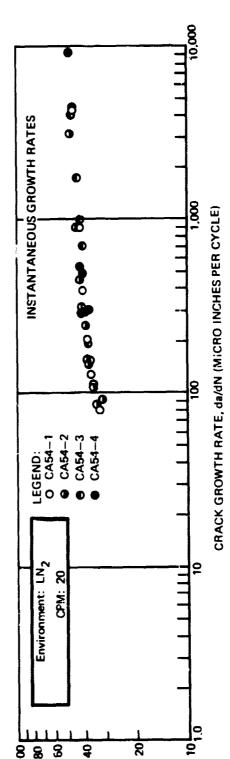
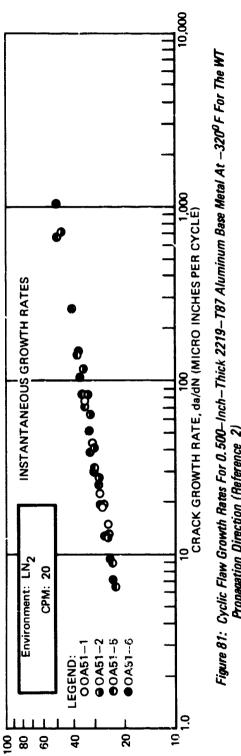


Figure 80: Cyclic Flaw Growth Rates for 0.500–Inch—Thick 2219—T67 Aluminum Base Metal at $-320^{\!0}$ F for the WT Propagation Direction (Reference 2)

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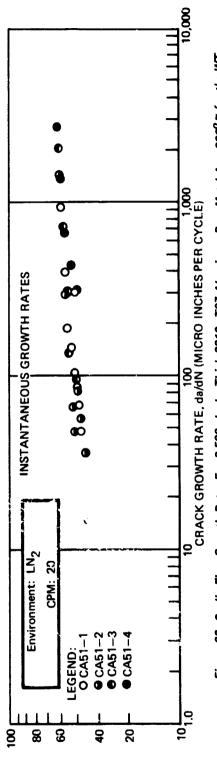


Figure 82: Cyclic Flaw Growth Rates For 0.500—Inch—Thick 2219—T87 Aluminum Base Metal At -320^{o} F for the WT Propagation Direction (Reference 2)

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MAXIMUM STRESS INTENSITY, K_{\parallel} (KSI $\sqrt{\parallel}$ IN)

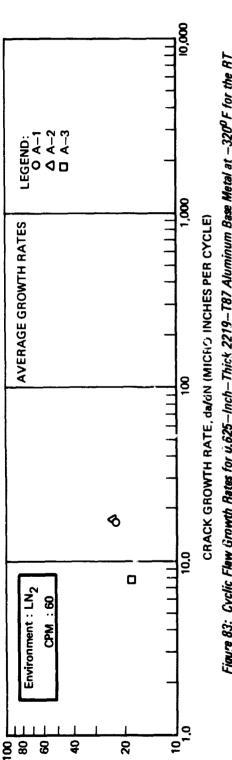


Figure 83: Cyclic Flaw Growth Rates for U.625—Inch—Thick 2219—T87 Aluminum Base Metal at —320°F for the RT Propagation Direction (Reference 3)

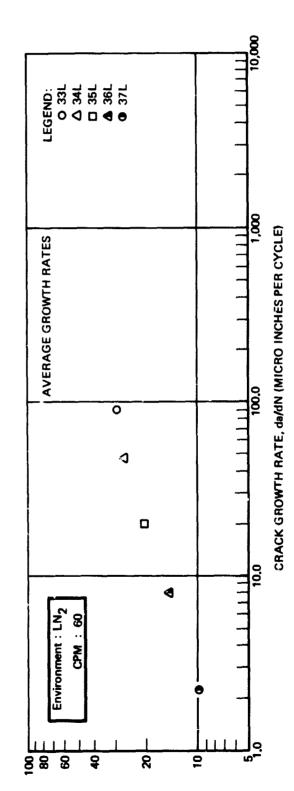
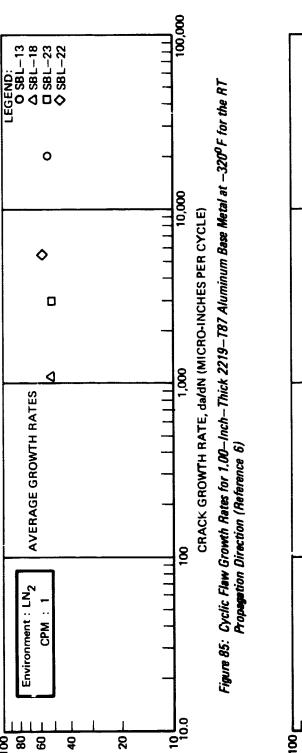


Figure 84: Cyclic Flaw Growth Sates for 0,250-Inch-Thick 2219-T87 Aluminum Base Metal at -320^{o} F for the RT Propagation Direction (Reference 26)



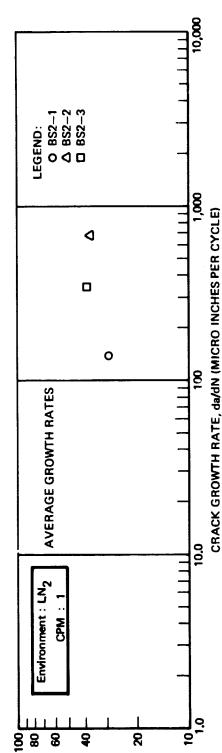


Figure 86: Cyclic Flaw Growth Rates for 0.500–Inch–Thick 2219–T87 Aluminum Base Metal at -320^{o} F for the RT Propagation Direction (Reference 23)

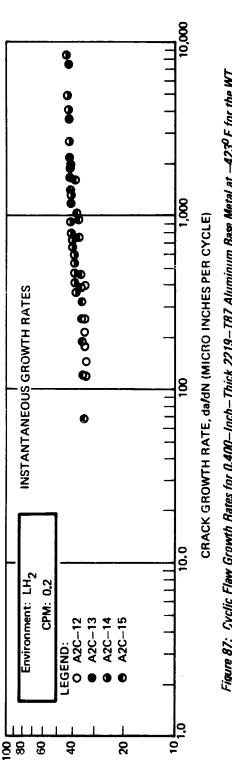


Figure 87: Cyclic Flaw Growth Rates for 0.400-Inch-Thick 2219-T87 Aluminum Base Metal at -423º F for the WT Propagation Direction (Reference 5)

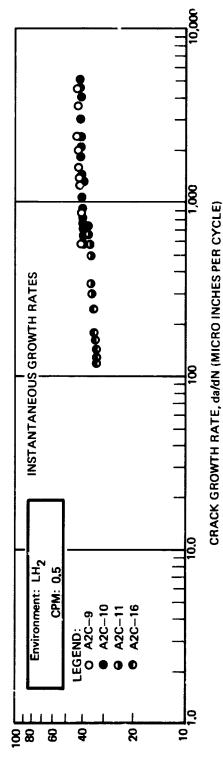
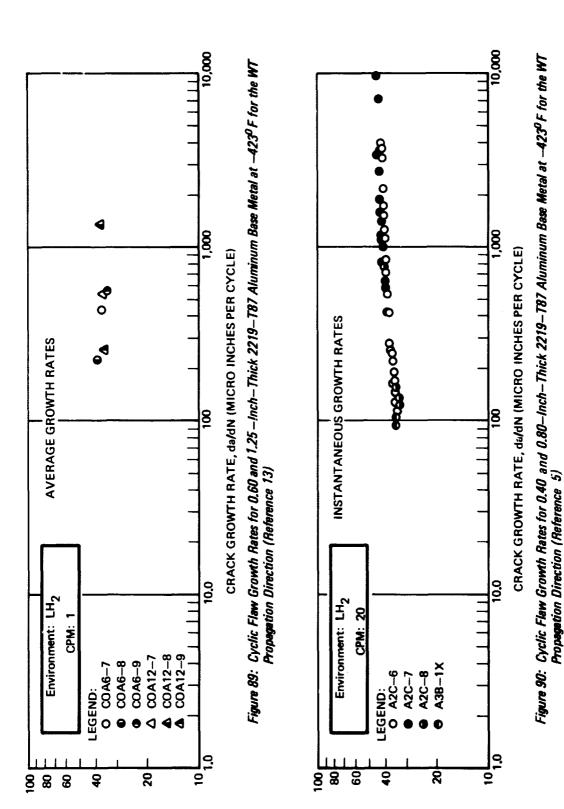
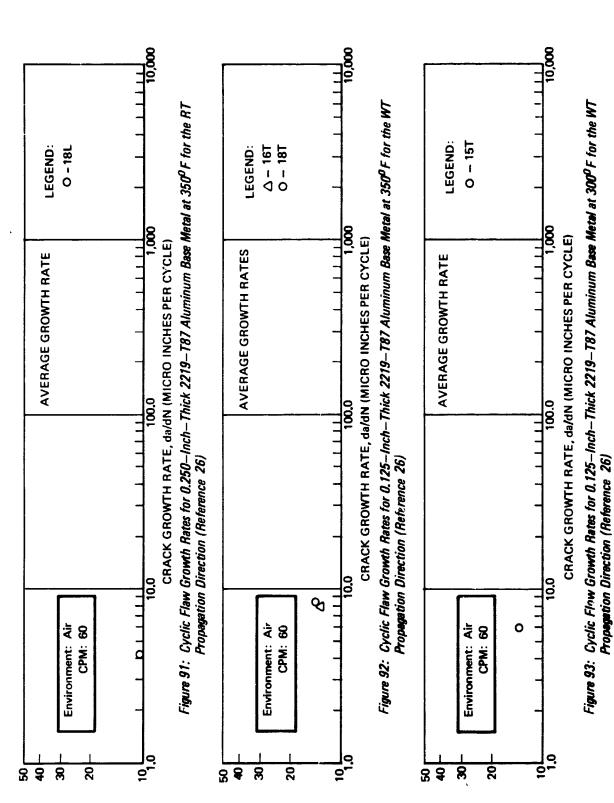


Figure 88: Cyclic Flaw Growth Rates for 0.400—Inch—Thick 2219—T87 Aluminum Base Metal at -423^0 F for the WT Propagation Direction (Reference 5)

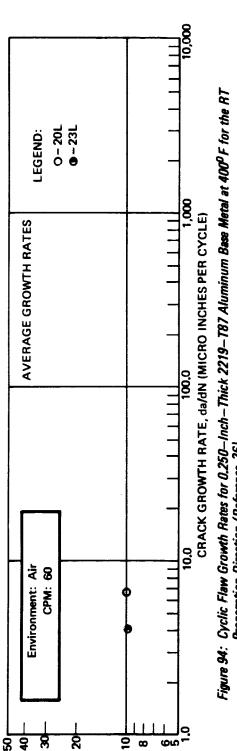
MAXIMUM STRESS INTENSITY, K_{\parallel} (KSI $\sqrt{\ln}$)



MAXIMUM STRESS INTENSITY, K_{\parallel} (KSI $\sqrt{1N}$)



MAXIMUM STRESS INTENSITY, K_{\parallel} (KSI $\sqrt{|N|}$)



Propagation Direction (Reference 26)

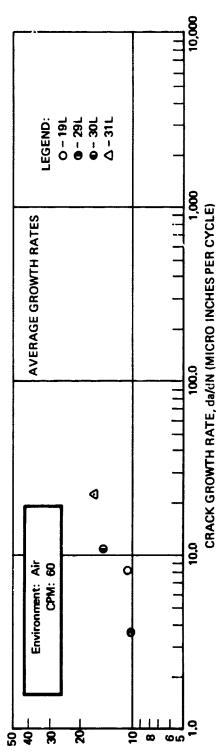


Figure 95: Cyclic Flaw Growth Rates for 0.250—Inc.1—Thick 2219—T87 Aluminum Base Metal at 350º F for the HT Propagation Diraction (Reference 26)

MAXIMUM STRESS INTENSITY, κ_{\parallel} (KSI $\sqrt{\text{iN}}$)

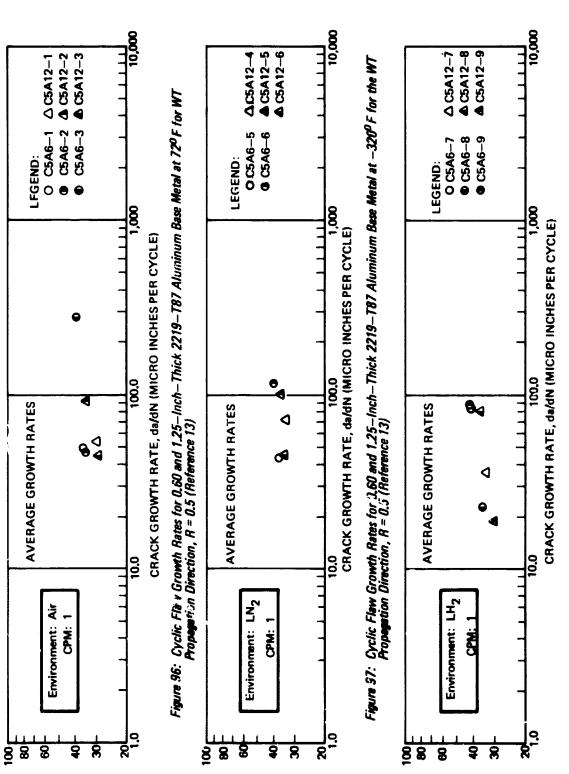


Figure 98: Cyclic Flaw Growth Rates for 9.60 and 1.25—Inch—Thick 2219—T87 Aluminum Base Metal at -423ºF for the WT Propagation Diraction, R = 0.5 (Reference 13)

MAXIMUM STRESS INTENSITY,

 $\mathbf{K}^{\mathbf{I}}$

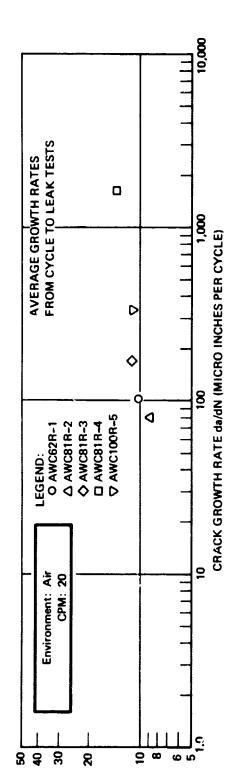


Figure 99: Cyclic Flaw Growth Rates for 0.125-Inch-Thick 2219 Aluminum Weldments at 72º F (Reference 3)

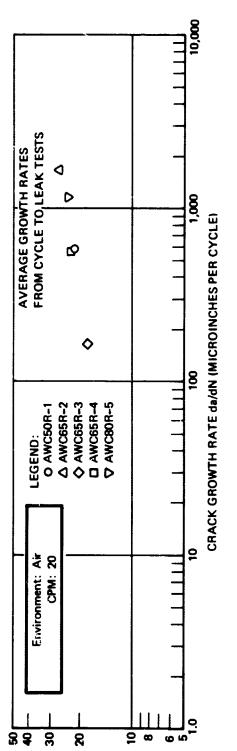


Figure 100: Cyclic Flaw Growth Rates for 1.00-Inch-Thick 2219 Aluminum Weldments at 72º F (Reference 3)

MAXIMUM IRWIN STRESS INTENSITY, K_{\parallel} (KSI $\sqrt{\ln}$

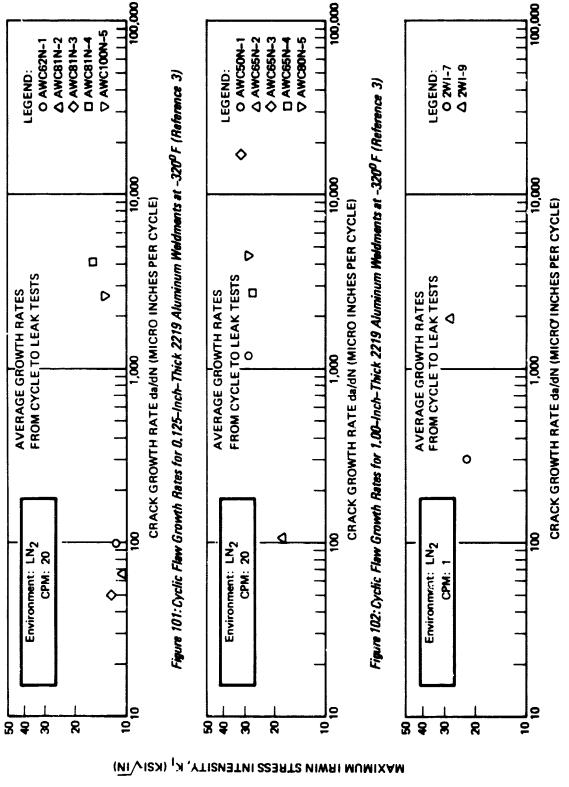


Figure 103: Cyclic Flaw Growth Rates for 1.00-Inch-Thick 2219 Aluminum Weldments at -320°F (Reference 23)

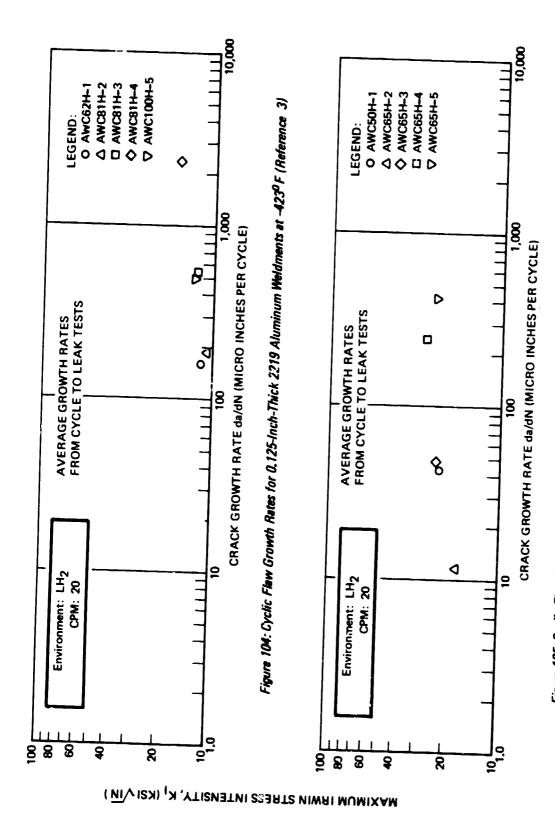


Figure 105: Cyclic Flaw Growth Rates for 1.00-Inch-Thick 2219 Aluminum Weldments at -423º F (Reference 3)

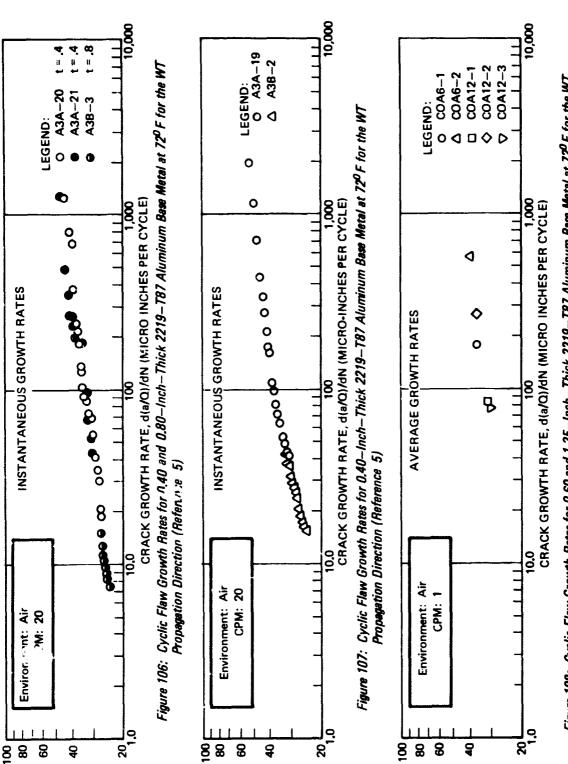


Figure 108: Cyclic Flaw Growth Rates for 0.60 and 1.25-Inch-Thick 2219–T87 Aluminum Base Metal at 72 $^{
m P}$ F for the WT Propagation Diraction (Reference 13)

MAXIMUM STRESS INTENSITY, KI (KSI

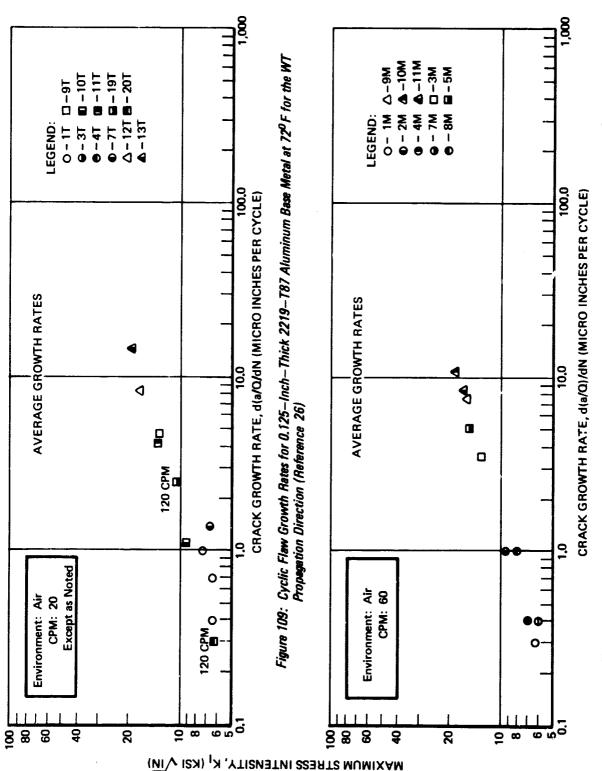


Figure 110: Cyclic Flaw Growth Rates for 0.125—Inch—Thick 2219—T87 Aluminum Base Metal at 72 $^{\!0}$ F for the WT Propagation Direction (Reference 26)

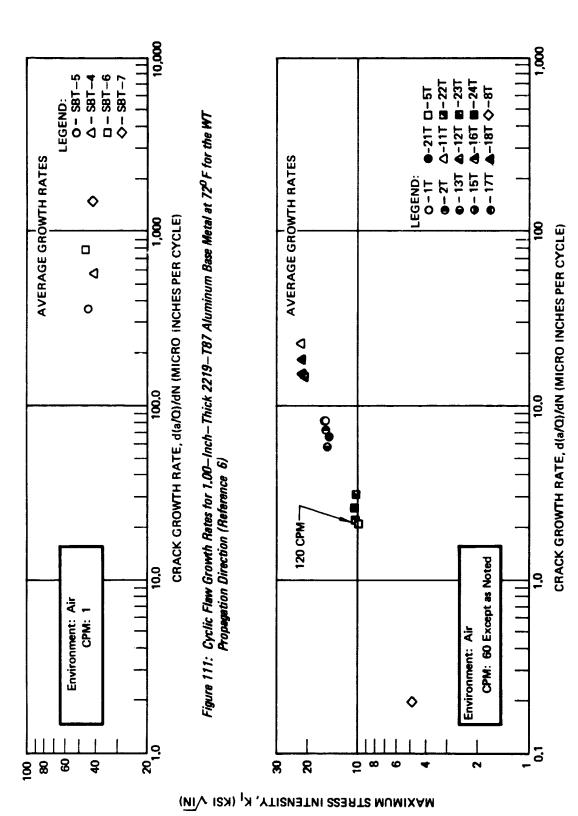
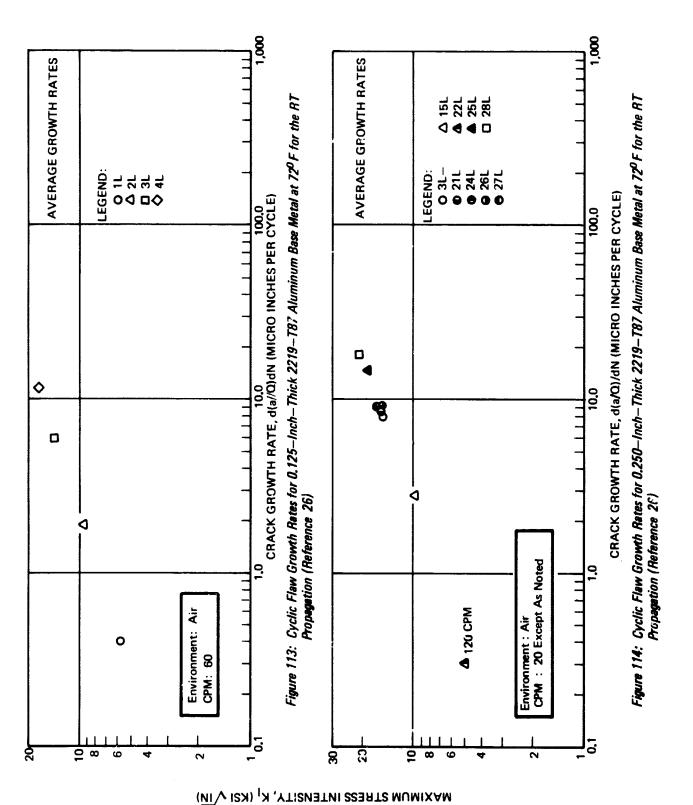


Figure 112: Cyclic Flaw Growth Rates for 0.250–Inch–Thick 2219–187 Aluminum Base Metal at 72 $^{
m 0}$ F for the WT Propagation Direction (Reference 26)



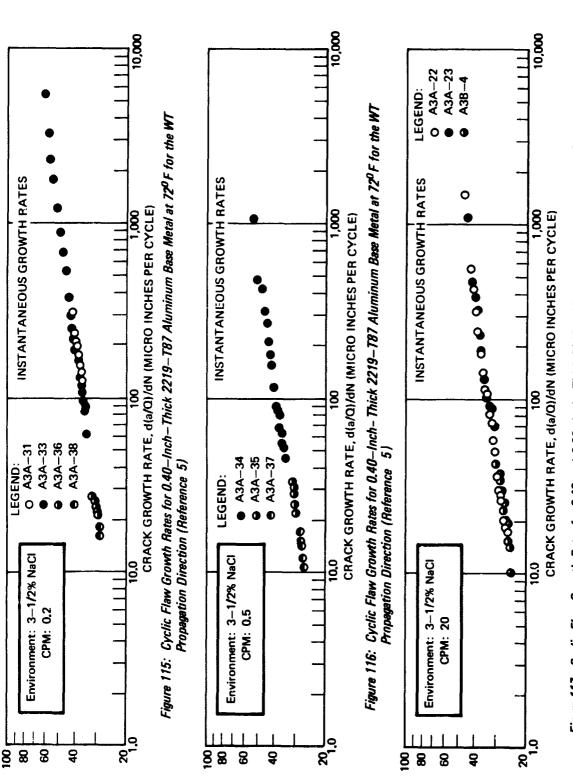


Figure 117: Cyclic Flaw Growth Rates for 0.40 and 0.80—Inch—Thick 2219—T87 Aluminum Base Metal at 72º F for the WT Propagation Direction (Reference 5)

MAXIMUM STRESS INTENSITY,

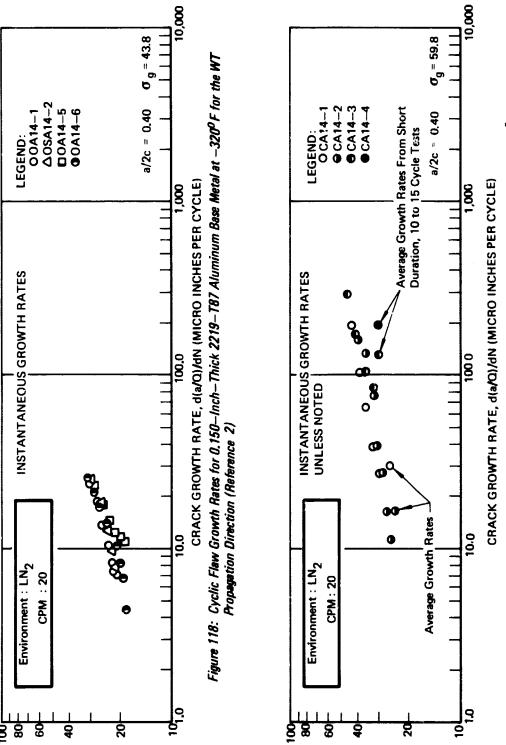


Figure 119: Cyclic Flaw Growth Rates for 0.150-Inch-Thick 2219–T87 Aluminum Base Metal at -320^0 F for the WT Propagation Direction (Reference 2)

MAXIMUM STRESS INTENSITY, K $_{
m I}$ (KSI $\sqrt{
m IM}$)

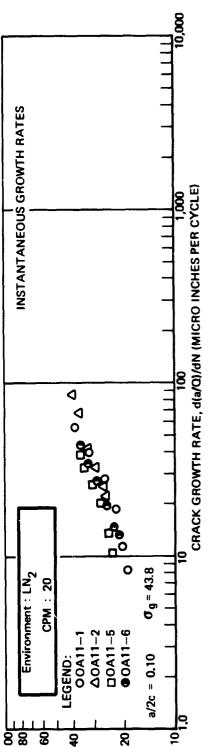


Figure 120: Cyclic Flaw Growth Rates for 0.150—Inch—Thick 2219—T87 Aluminum Base Metal at —320°F for the WT Propagation Direction (Reference 2)

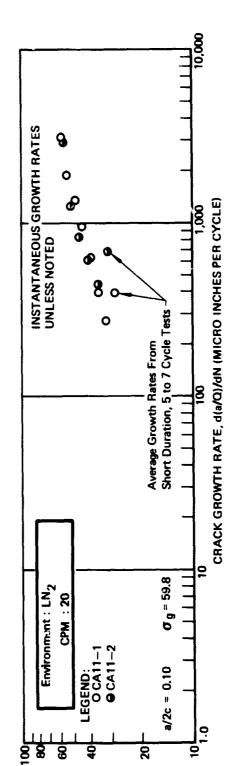


Figure 121: Cyclic Flaw Growth Rates for 0.150-Inch-Thick 2219-T87 Aluminum Base Metal at -320°F for the WT Propagation Direction (Reference 2)

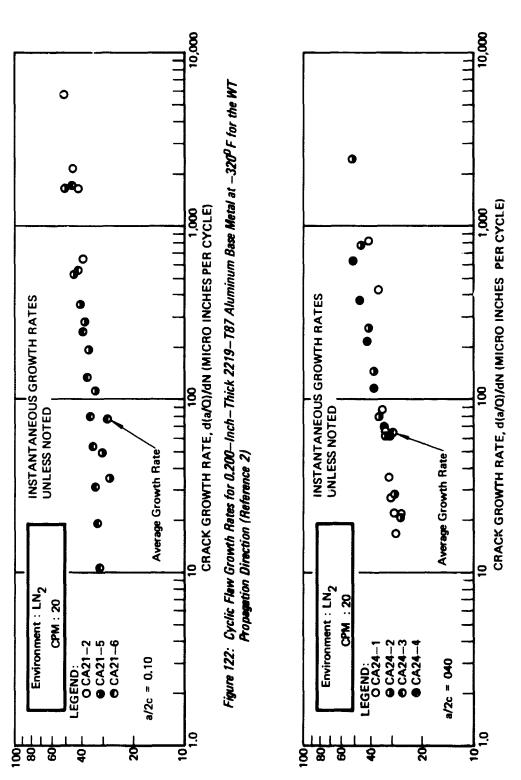


Figure 123: Cyclic Flaw Growth Rates for 0.200—Inch—Thick 2219—T87 Aluminum Base Metal at $-320^{o}F$ for the WT Propagation Direction (Reference 2)

MAXIMUM STRESS INTENSITY, $K_{\frac{1}{4}}$ (KSI $\sqrt{10}$)

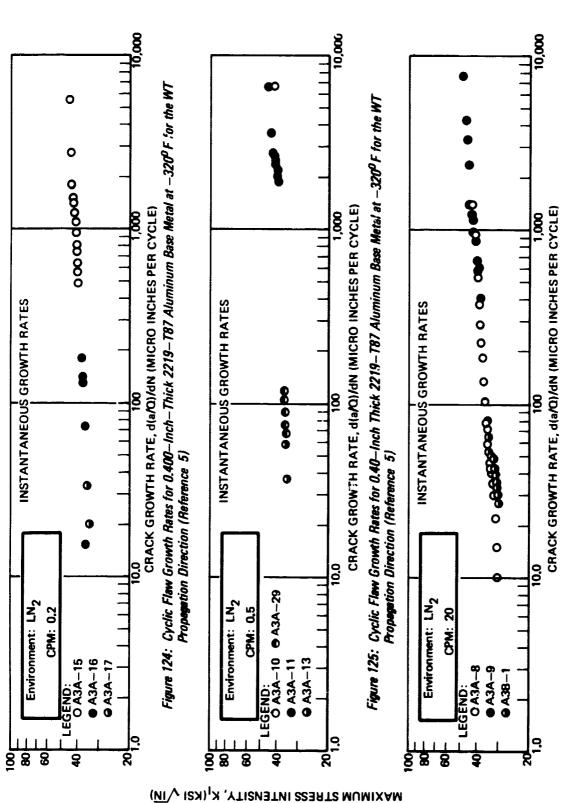


Figure 126: Cyclic Flaw Growth Rates for 0.40 and 0.80—Inch.-Thick 2219—T87 Aluminum Base Metal at -320ºF for the WT Propagation Direction (Reference 5)

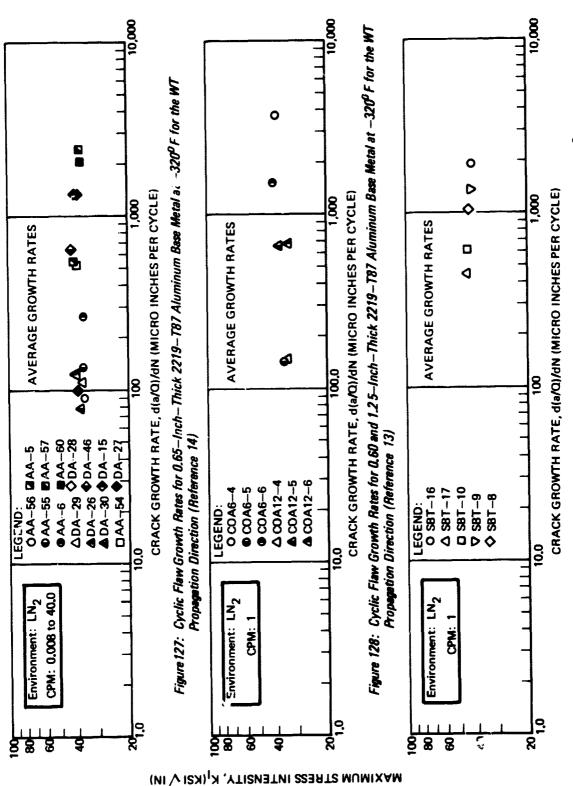


Figure 129: Cyclic Flaw Growth Rates for 1.00—Inch—Thick 2219—T87 Aluminum Base Metal at -320°F for the WT Propagation Diraction (Reference 6)

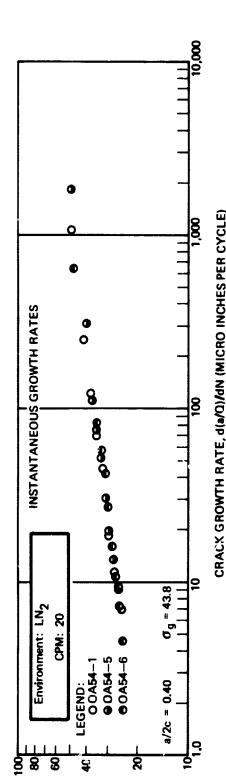


Figure 130: Cyclic Flaw Growth Rates for 0.50C-Inch-Thick 2219-TB7 Aluminum Base Metal at -320^{o} F for the WT Propagation Direction (Reference 2)

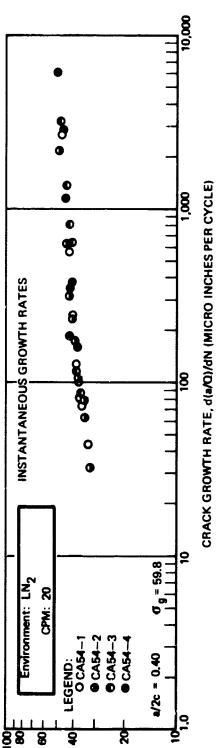
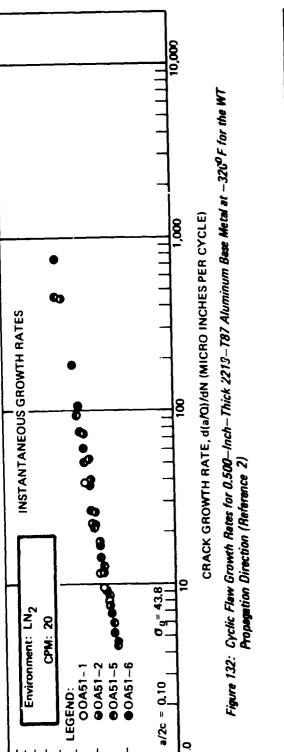


Figure 131: Cyclic Flaw Growth Rates for 0.500—Inch—Thick 2219—T87 Aluminum Base Metal at -3200 F for the WT Propagation Direction (Reference 2)

MAXIMUM STRESS INTENSITY, K_{\parallel} (KSI $\sqrt{10}$)



40

8

8

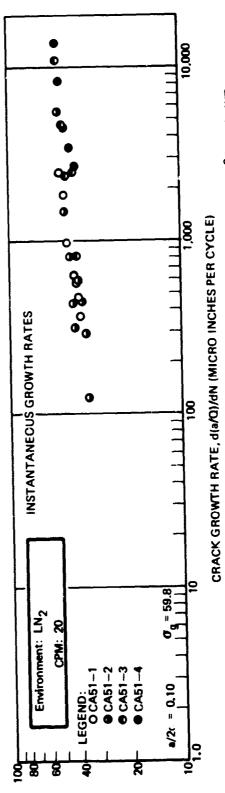
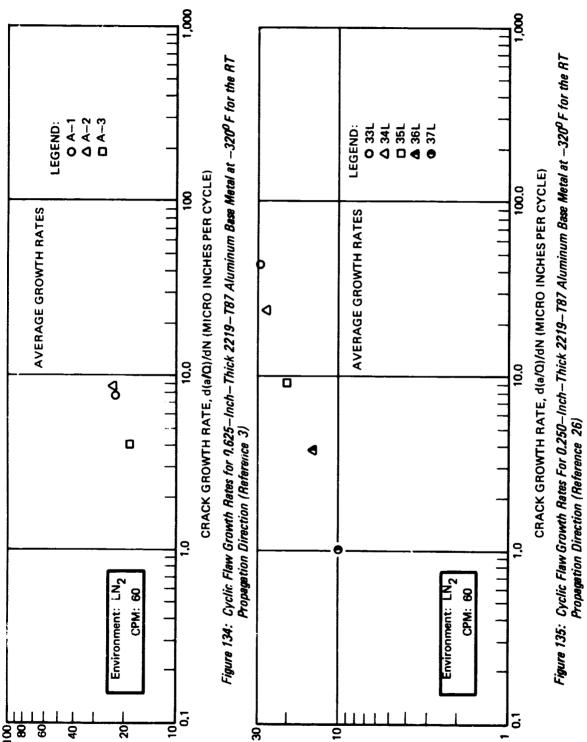


Figure 133: Cyclic Flaw Growth Hates for 9.500-Inch-Thick 2219-T87 Aluminum Base Metal at -3200 F for the WT Propagation Direction (Reference 2)

MAXIMUM STRESS INTENSITY, κ_1 (KSI $\sqrt{10}$)



MAXIMUM STRESS INTENSITY, K_1 (KSI \sqrt{I} II)

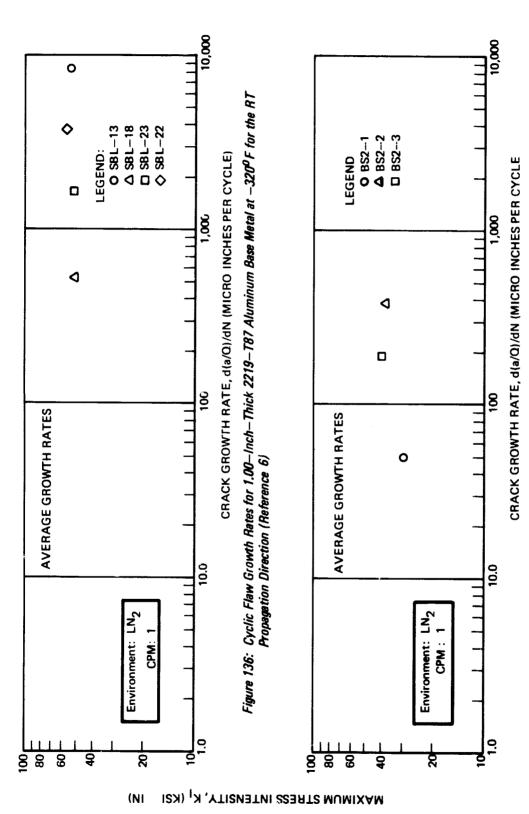


Figure 137: Cyclic Flaw Growth Rates for 0.500—Inch—Thick 2219—T87 Aluminum Base Metal at --320º F for the RT Propagation Direction (Reference 23)

Figure 138: Cyclic Flaw Growth Rates for 0.400-Inch-Thick 2219-T87 Aluminum Base Metal at -423ºF for the WT Propagation Direction (Reference 5) CRACK GROWTH RATE, d(a/Q)/dN (MICRO INCHES PER CYCLE) October de company of the poor INSTANTANEOUS GROWTH RATES INSTANTANEOUS GROWTH RATES 10.0 Environment : LN₂ **CPM: 0.2** 8 8 8 6 2 8 MAXIMUM STRESS INTENSITY,

10,000

00,

● A2C-13

9 A2C-14

O A2C-12

LEGEND

O A2C-15

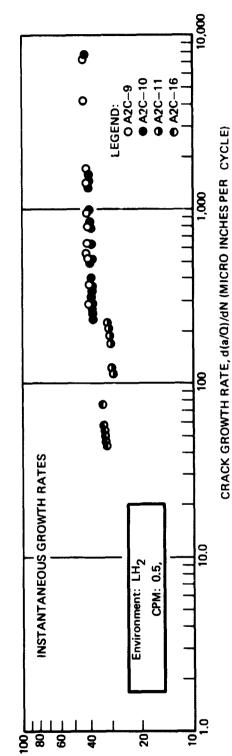
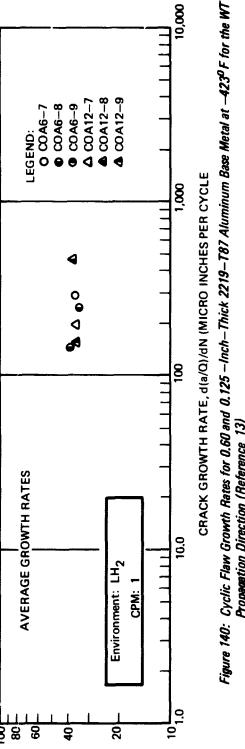


Figure 139: Cyclic Flaw Growth Rates for 0.400-Inch-Thick 2219-T87 Aluminum Base Metal at -423º F for the WT Propagation Direction (Reference 5)



Propagation Direction (Reference 13)

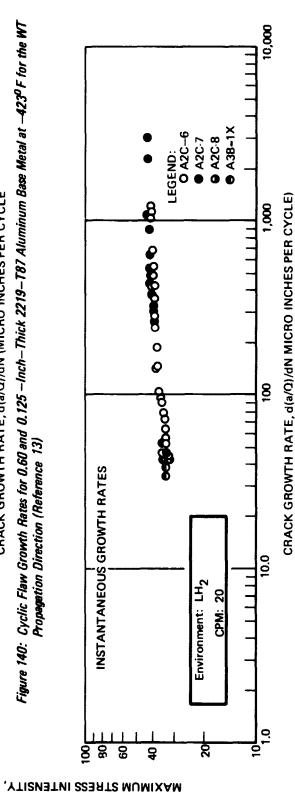


Figure 141: Cyclic Flaw Growth Rates for 0.400 and 0.800-Inch-Thick 2219-T87 Aluminum Base Metal at -423º F for the WT Propagation Direction (Reference 5)

 K^{I} (KSI $\sqrt{\underline{I}\underline{N}}$)

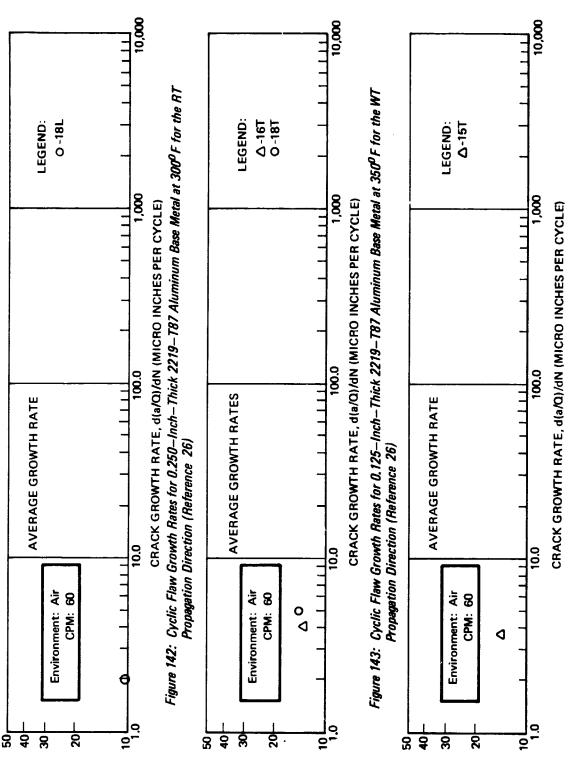


Figure 144: Cyclic Flaw Growth Rates for 0.125-Inch-Thick 2219-T87 Aluminum Base Metal at 300°F for the WT

Propagation Direction (Reference 26)

MAXIMUM STRESS INTENSITY, K_{\parallel} (KSI $\sqrt{1}$ IN)

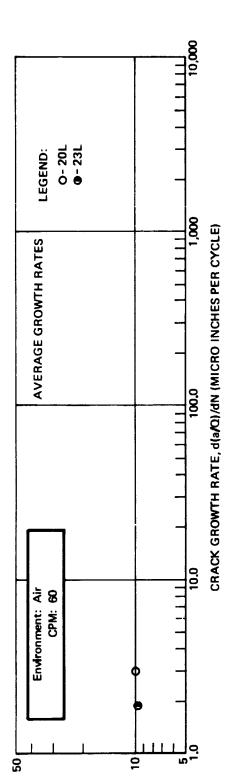


Figure 145: Cyclic Flaw Growth Rates for 0.250—Inch—Thick 2219—T87 Aluminum Base Metal at 400°F for the RT Propagation Direction (Reference 26)

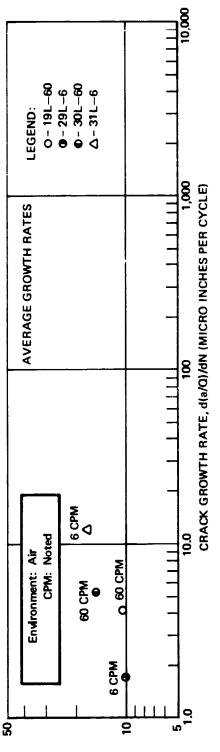


Figure 146: Cyclic Flaw Growth Rates for 0.250-Inch-Thick 2219-T87 Aluminum Base Metal at $350^{o}F$ for the RT Propagation Direction (Reference 26)

MAXIMUM STRESS INTENSITY, K_{\parallel} (KSI $\sqrt{\Pi N}$)

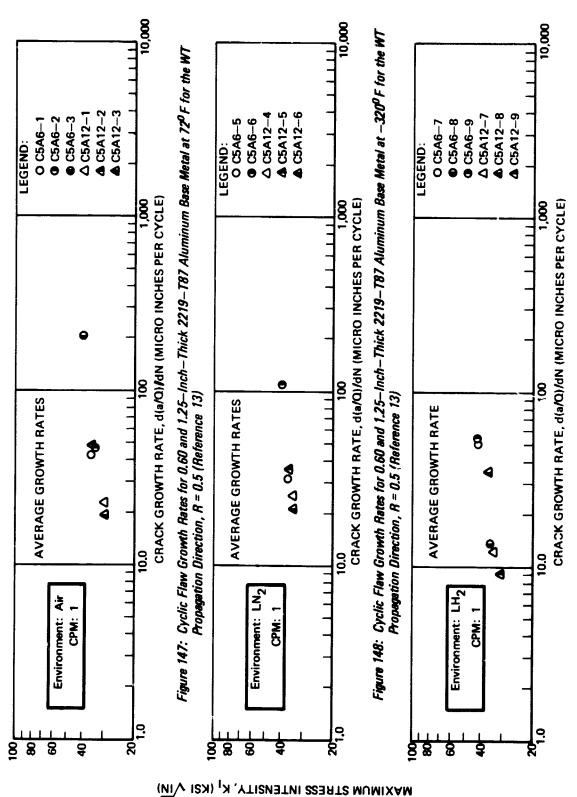


Figure 149: Cyclic Flaw Growth Rates for 0.60 and 1.25—Inch—Thick 2219—TB7 Aluminum Base Metal at -423º F for the WT Propagation Direction, R = 0.5 (Reference 13)

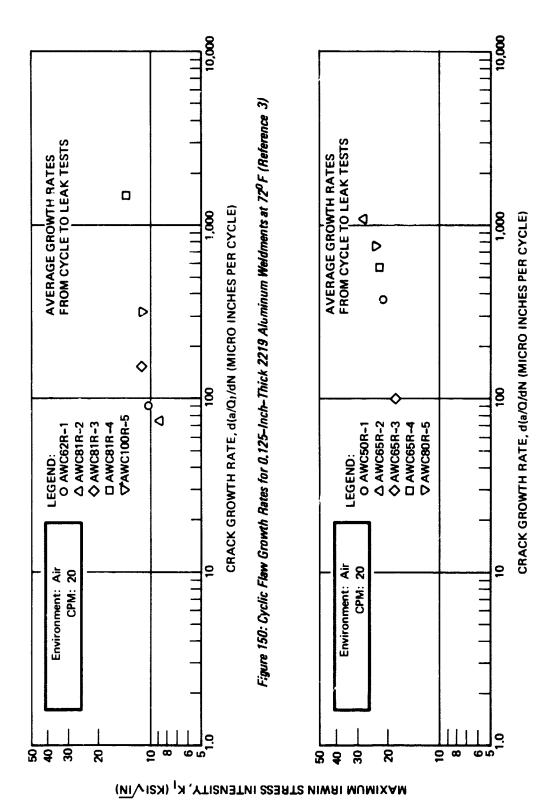


Figure 151: Cyclic Flaw Growth Rates for 1,00-Inch-Thick 2219 Aluminum Weldments at 72º F (Reference 3)

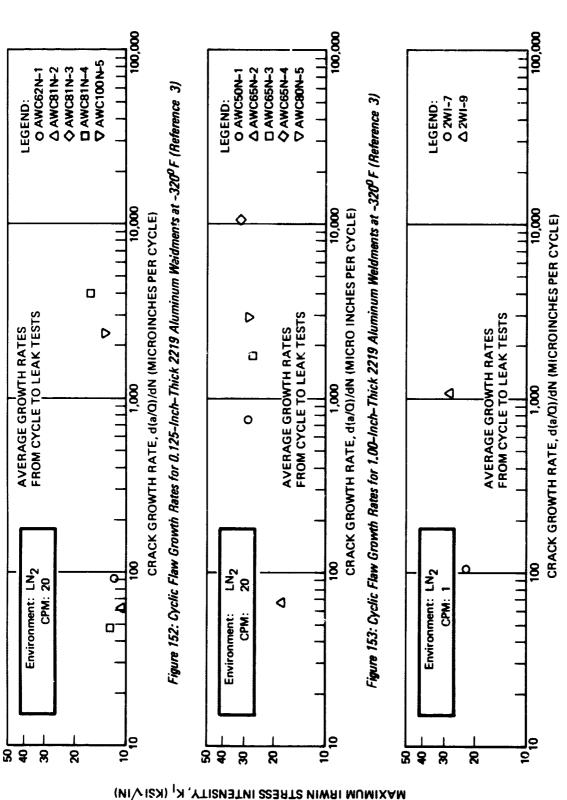


Figure 154: Cyclic Flaw Growth Rates for 1.00-Inch-Thick 2219 Aluminum Weldments at -320° F (Reference 23)

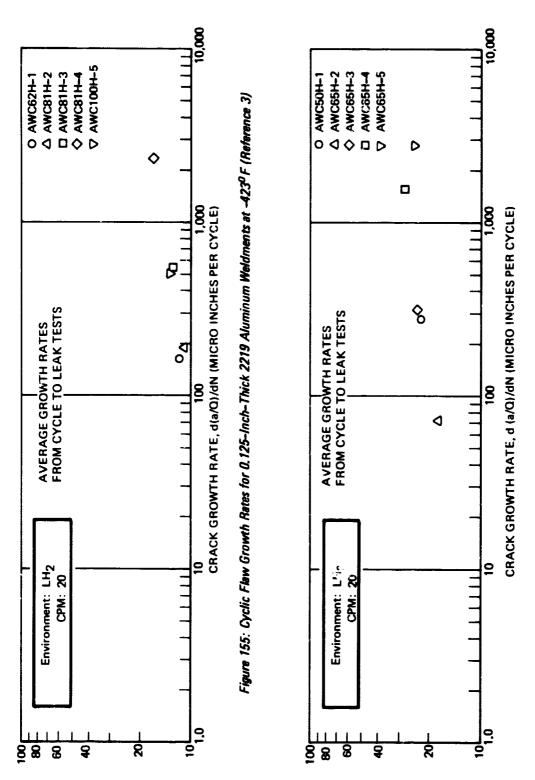


Figure 156:Cyclic Flaw Growth Rates for 1.00-Inch-Thick 2219 Aluminum Weldments at -423º F (Reference 3)

MAXIMUM IRWIN STRESS INTENSITY, K_{\parallel} (KSI \forall IN)

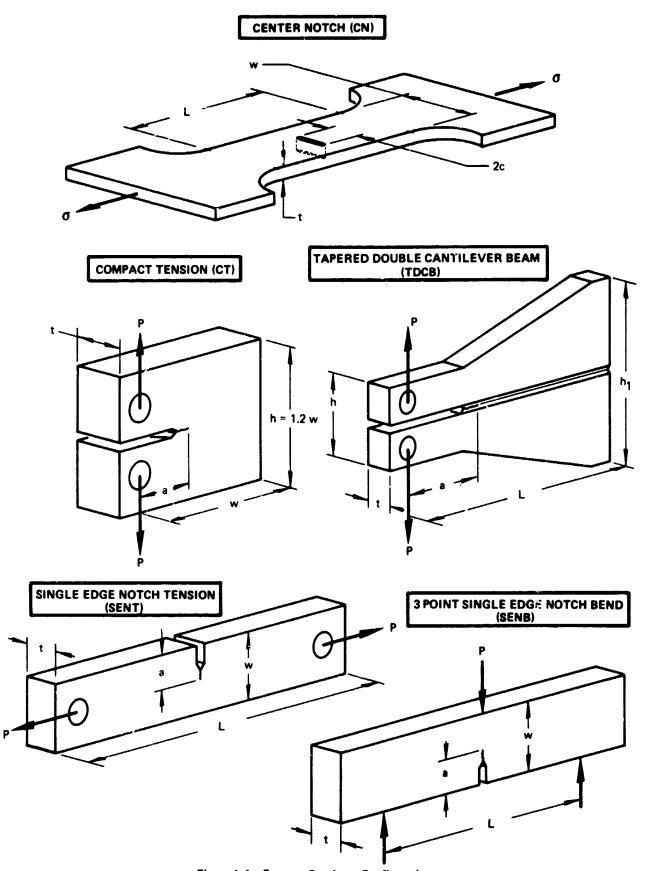


Figure A-1: Fracture Specimen Configurations

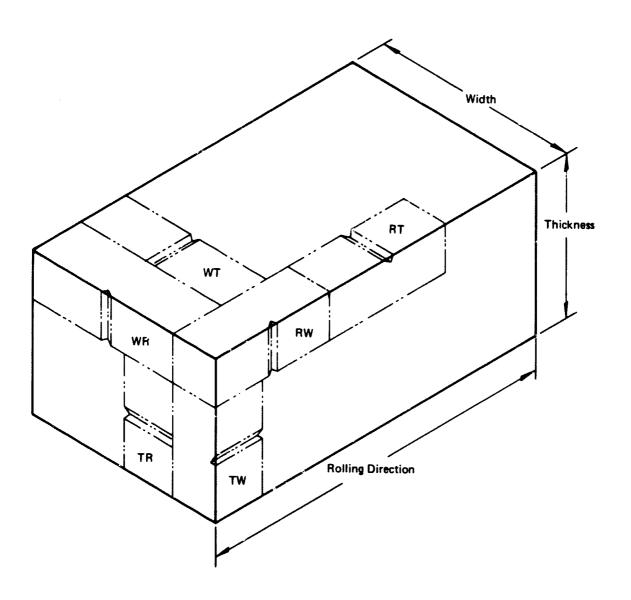


Figure A-2: Propagation Direction Code

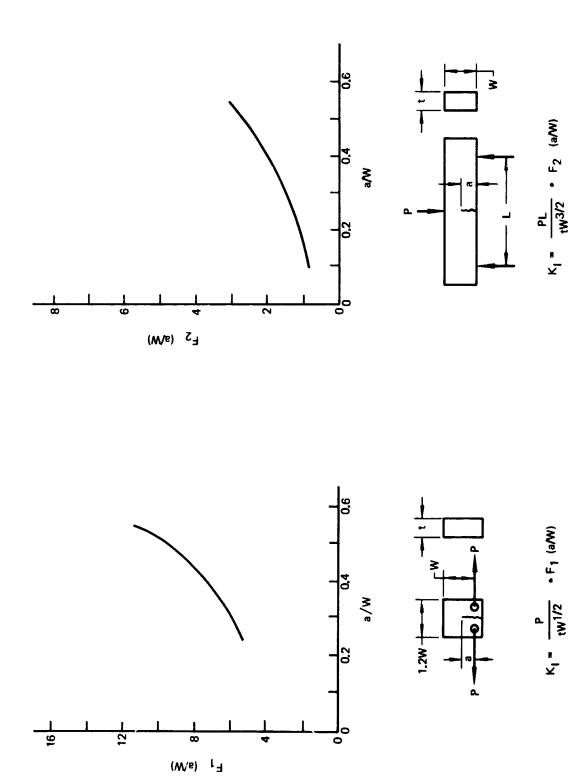


Figure A-3 : Stress Intensity Expressions For CT and SENB Specimens

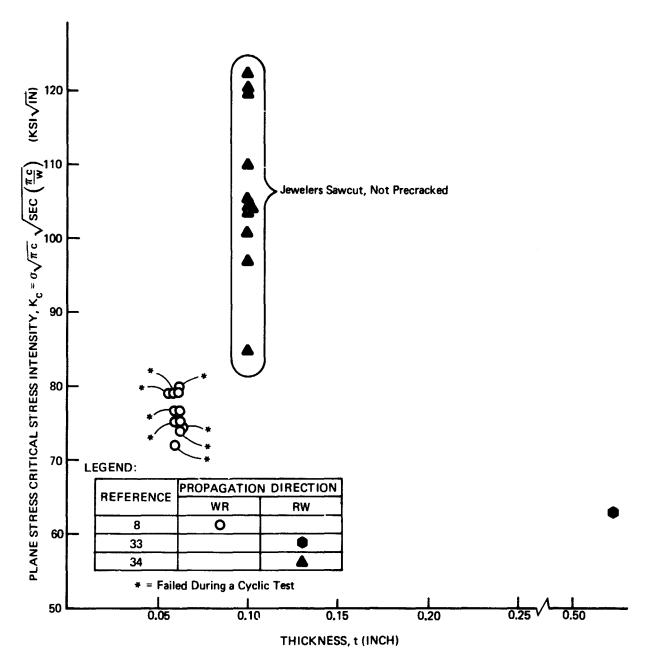


Figure A-4 : Plane Stress Critical Stress Intensity Vs. Thickness, 2219–T87 Aluminum Alloy Tested in Room Temperature Air

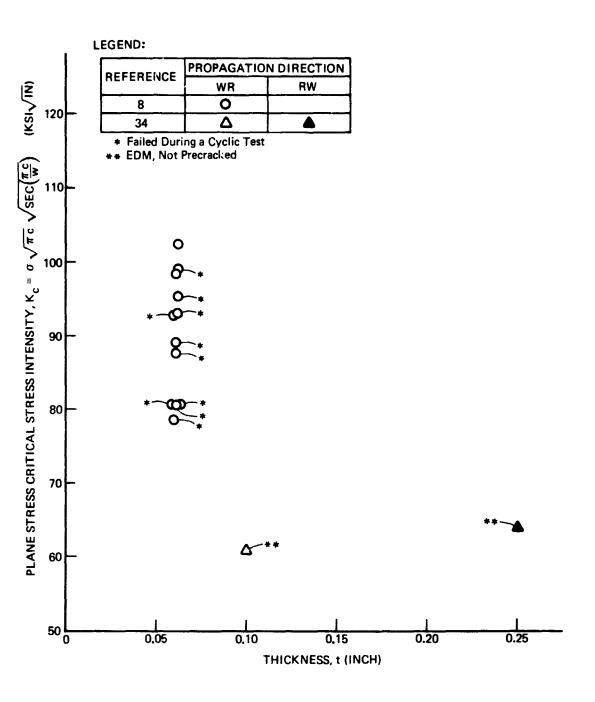


Figure A-5: Plane Stress Critical Stress Intensity Vs. Thickness, 2219-T87 Aluminum Alloy
Tested in -320° F Liquid Nitrogen

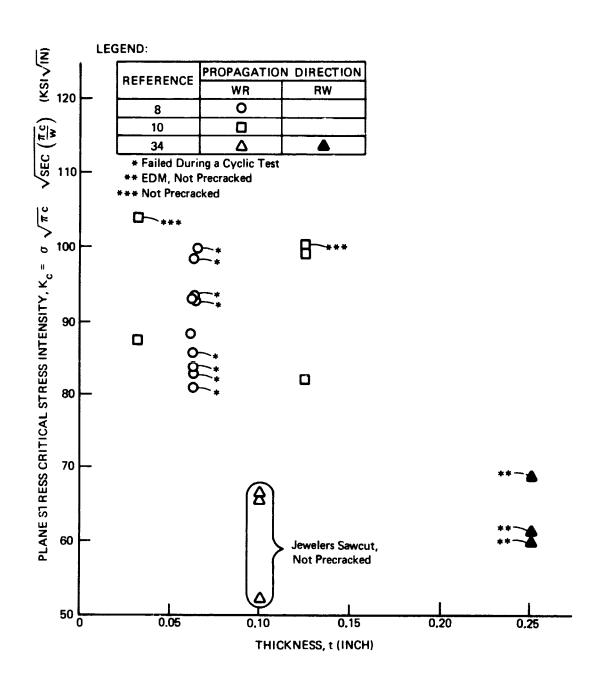


Figure A-6 : Plane Stress Critical Stress Intensity Vs. Thickness, 2219-T87 Aluminum Alloy Tested in -423° F Liquid Hydrogen

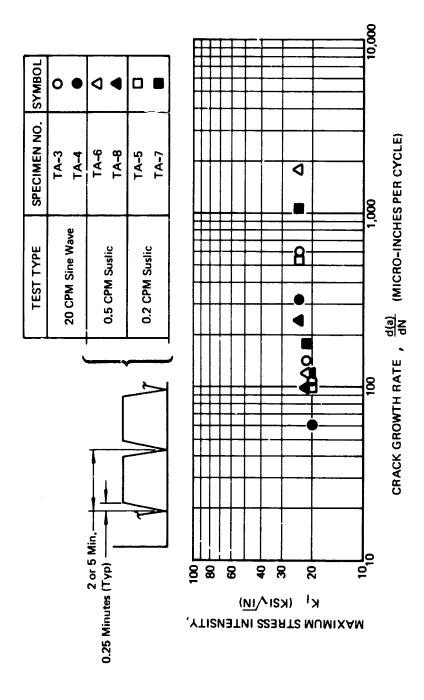


Figure A-7: Average Stress Intensity, K $_{m h}$ Vs. Crack Growth Rate, $rac{da}{dN}$, 1.0 Inch Thick 2219-T87 Aluminum Alloy Tapered DCB Specimens Tested at Room Temperature in 3-1/2% NaCl Solution. WR Propagation Direction (Reference 5.)

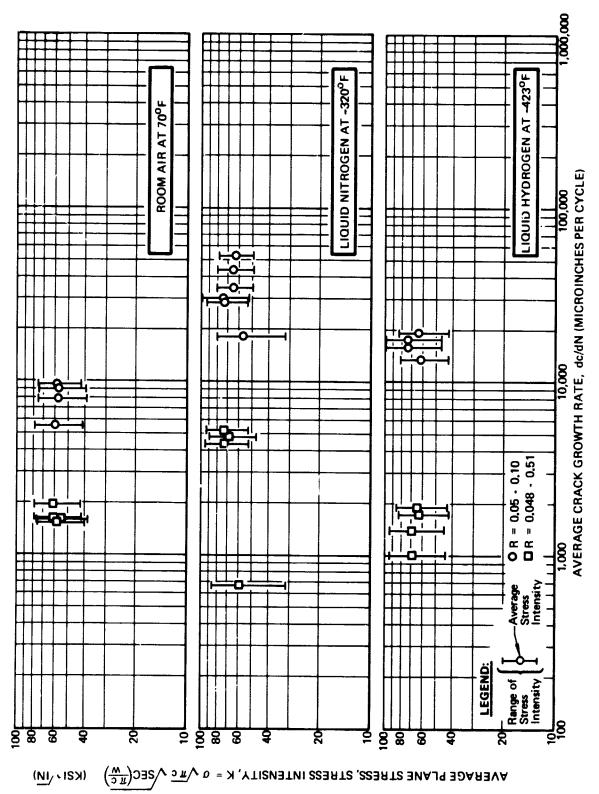


Figure A-8: Average Plane Stress Stress Intensity Vs. Average Growth Rate, 2219-187 Aluminum Alloy, 0.063 Inch Sheet, WR Propagation Direction (All Points From Reference 8)

Table 1 : Ultimate and Yield Strength Summary 2219-T87 Aluminum Alloy Longitudinal Grain

2202527		TEMPERATUR	E
PROPERTY	-423 ⁰ F	-320°F	RT
Mean F _{tu} (Ksi)	99.3	83.8	68.7
99% P, 95% C F _{tu} (Ksi)	90.5	77.9	64.3
Mean F _{ty} (Ksi)	72.2	65.9	56.7
99% P, 95% C F _{ty} (Ksi)	65.8	59.4	51.4

Table 2 : Ultimate and Yield Strength Summary 2219–T87 Aluminum Alloy Long Transverse Grain

2202525		TEMPERATURE	
PROPERTY	-423 ⁰ F	-320 ⁰ F	RT
Mean F _{tu} (Ksi)	100.4	84.8	69.0
99% P, 95% C F _{tu} (Ksi)	94.1	78.7	64.6
Mean F _{ty} (Ksi)	71,8	65.9	56.2
99% P, 95% C F _{ty} (Ksi)	64.7	59.8	50.7

Table 3 : Ultimate and Yield Strength Summary, GTA Welded 2219-T87 Aluminum Alloy, No Post Weld Heat Treatment

PROPERTY	1	EMPERATURE	
PHOPERIT	-423 ⁰ F	-320 ^o F	RT
Mean F _{tu} (Ksi)	62.9	54.4	41.8
99% P, 95% C F _{tu} (Ksi)	50.6	45.6	34.1
Mean F _{ty} (Ksi)	30.2 [>>	28.6 [>	24.6
99% P, 95% C F _{ty} (Ksi)	[>>	[>	

[&]quot;Apparent" Mean Values Reported, Not Enough Data Points To Firmly Establish Mean F_{ty}

Table 4 : Ultimate Strength Summary, GMA Welded 2219–T87 Aluminum Alloy, No Post Weld Heat Treatment

PROPERTY		TEMPERATURE	
PROPERTY	-423 ⁰ F	-320 ⁰ F	RT
Mean F _{tu} (Ksi)	62.7	56,0	42.9
99" P, 95% C F _{tu} (Ksi)	45.8	42.3	34.7

Not Enough Data Points Were Found for an Accurate Determination

Table 5 : Mean Values of Fracture Toughness, K_{IE}, 2219-T87 Aluminum Alloy (From Surface Flawed Specimen Tests)

	1	EMPERATURE	
PROPAGATION DIRECTION	-423 ⁰ F	-320 ⁰ F	RT
RT	52,3 Ksi√in	48,6 Ksi√In	46.2 Ksi√In
WT	47.0 Ksi√In	47,0 Ksi√In	41,3 Ksi√In

"Apparent" Mean Values Reported, Not Enough Data Points To Firmly Establish Mean K_{IE}

Table 6 : Mean Values of Fracture Toughness, K_{IE}, GTA Welded 2219–787 Aluminum Alloy (From Surface Flawed Specimen Tests)

	TEMPERATURE	
-423 ⁰ F	-320°F	RT
∑ 23.9 Ksi√In	▷ 28.1 Ksi√In	NA

"Apperent" Meen Values Paported, Not Enough Data Points To Firmly Establish Meen K_{IE}

Table 7 : Threshold Values for 2219-T87 Aluminum Alloy Base Metal

TEMP	Tiallanacountra	PROPAGATION THICKNESS NO. OF	THICKNESS	NO. OF	КТН	KIE	A SO SOCIOS		2	SEIS STATE OF
(PF)	ENVIRONMENT	DIRECTION	(INCH)	POINTS	(KSIVIN)	(KSh,/IN)	Source or AlE	NTH/NIE	וני	COMMENTS
			0.125	9	> 23.0	ł	I	-	92	Not Enough Data For Analysis
			0.0	4	40.8	42.6	Avg. of 3 Points From Ref.	0.96	9	24 Hour Test
	Ąĸ	¥	09.0	ю	< 39.0	43.9	Avg. of 28 Points From Ref.	< 0.89	2	20 Hour Test
			0.65	8	32.0 to 33.6	37.7	Avg of 27 Points From Ref.	a85 to a89	=	24 – 38 Hour Tests
			0.50	6	6'98 <	44.4	Avg. of 9 Points From Ref.	> 0.83	74	20.4 Hour Test
			1.00	2	39.4	42.6	Avg. of 3 Points From Ref	0.92	9	24 Hour Test
	3%% NaCi	¥	0.60	-	> 39.1	43.4	Endpoint	< 0.90	¤	16 Hour Test
			0.40	က	3	41.3	Overall Mean	0.83	2	10 Hour Test
	GH ₂	TW.	09.0	2	>38.7	44.5	Endpoint	> 0.87	æ	10 Hour Test
22	Distilled H ₂ O	Τ₩	09.0	2	> 39.4	43.9	Avg. of 28 Points From Ref.	>0.90	z	16 Hour Test
	Dye Penetrant	ΙM	09:0	2	>37.2	7.44	Endpoint	> 0.83	Z	15 Hour Test
	FLOX	TW.	0.60	က	38.8	1.4	Endpoint	9870	u	10 Hour Test
	OF ₂	TW	09'0	2	39.0	43.0	Endpoint	0.91	Z	11 Hour Test
	Argon	¥	0.60	-	39.1?	43.9	Avg. of 28 Points From Ref.	0.89 ?	z	Only 1 Data Point From A 1 Hour Sustained Test
	Trichloroethylene	WT	090	2	39.7	44.6	Endpoint	68'0	z	16.2 Hour Test
	605	WT	09'0	2	39.1	6.44.3	Endpoint	98'0	Z	12 Hour Test
	172 db	TW.	1.00	1	<43.7		_	1	9	Not Enough Data for Analysis
	Noise Level	RT	1.00	ı	<51.0	_	1	-	9	Not Enough Data for Analysis
-230	172 db Noise Level, GN ₂	RT	1.00	3	>52.1	58.3	Avg. of 2 Points From Ref.	> 0.89	9	4,74 Hour Test , K _{IE} wes Taken From Tests at -320°F

Table 7 : Threshold Values for 2219-187 Aluminum Alloy Base Metal (Continued)

TEMP. EN	ENVIRONMENT	PROPAGATION THICKNESS NO. OF DIRECTION (INCH) POINTS	THICKNESS (INCH)	NO. OF POINTS	KTH (KSI VIN)	K _{IE} (KSI√IN)	SOURCE OF KIE	KTH/KIE	REF	COMMENTS	
			1.00	3	42.9	47.2	Avg. of 2 Points From Ref.	0.91	9	24 Hour Test	
	_	¥	0,40	•	£0.1	47.0	Overall Mean	0.85	ß	10 Hour Test	
	LN2		0.65	18	34.4 -36.5	42.0	Avg. of 5 Points From Ref.	0.82 -0.87	7	24.6 - 120.0 Hour Tests	
		tα	1.00	s	51.0	58.3	Avg. of 2 Points From Ref.	0.87	9	21.75 Hour Test	
			0.50	3	-	ı		1	23	Not Enough Data for Analysis	
	GH ₂	WT	0.60	2	> 41.2	47.0	Overall Mean	> 0.87	Z	20.1 Hour Test	
	FLOX	WT	09.0	2	> 40.6	47.0	Overall Mean	>0.86	Z	10.1 Hour Test	
	0F ₂	.Lw	0.60	2	>41.1	47.0	Overall Mean	> 0.87	Z	10 Hour Test	
	LO ₂	WT	0.60	2	> 41.0	47.0	Overall Mean	> 0.87	2	10 Hour Test	
	GH ₂	WT	09'0	3	>45.2	47.0	Overall Apparent Mean	> 0.96	Z	10 Hour Test, K _{1E} was Taken From Tests at -423 ⁰ F	
			0.60	ო	>44.2	47.0	Overall Apparent Mean	>0.94	Z	20 Hour Test	
	£	¥	0.65	7	>40.1	45.0	Avg. of 3 Points From Ref	>0.89	2	44 Hour Test	_
	•		0.40	'n	35.6 - 38.4	47.0	Overall Apparent Mean	Q.75-Q.82	ß	4.3 - 10.0 Hour Tests, Not Enough	_
										Data to Accurately Determine KTH	

Table 8 : Threshold Values for GTA Welded 2219-T87 Aluminum Alloy

TEMP. (OF)	ENVIRONMENT	THICKNESS NO OF (INCH) POINTS		KTH []> (KSI VIN)	K _{IE} (KSI V(N)	SOURCE OF K _{IE}	K _{TH} /K _{IE}	REF	COMMENTS
		0.90	2	23.7	1	1	1	22	16 Hour Test
	Air	0.95	9	I	I	ı	1	24	Large Amounts of Reported Growth at High Street I evels
									Preclude Threshold Determination
	3%% NaCi	0.90	2	< 23.8	-		-	22	23.9 Hour Test, Not Enough Data
ş	GH ₂	0.90	2	24.0	_	_	_	22	14.9 Hour Test
7	Distilled H ₂ O	0.90	2	23.8	ı	_	-	22	15.8 Hour Test
	Dye Penetrant	0:30	2	23.8	_	1	_	22	16 Hour Test
	FLOX	0.90	2	23.6	-	_	-	\mathbf{z}	10 Hour Test
	0F ₂	0.30	3	23.8	-	_	-	22	10 Hour Test
	Trichloroethylene	06:0	2	23.9	-	1	1	22	12 Hour Test
	GO ₂	0.90	2	23.8	1		-	22	13.5 Hour Test
		1.00	4	>29.1	ı	ı	ı	23	9.8 Hour Test
		06:0	-	27.3	ı	ı	ı	22	6 Hour Test
{	LN ₂	0.95	9	1	l	I	l	24	Large Amounts of Reported Growth at High Stress Levels Preclude Threshold Determination
-320	GH ₂	0.90	2	27.1	ļ	1	-	22	10 Hour Test
	FLOX	0.90	2	23.3	_	***	-	22	11.3 Hour Test
	0.52	0.90	2	23.3	ı	_	_	22	10 Hour Test
	LO2	0.90	2	27.0	ı	1	_	22	10 Hour Test
-413	GH ₂	0.90	5	26.9	l	+	ı	22	10 Hour Test
-423	LH2	0.90	2	27.3	ŀ		-	22	11.1 Hour Test
1									

IRWIN K, NO MK USED IN CALCULATION

Room Temperature (70º F-75º F) Tensile Properties of 2219-T87 Aluminum Alloy Base Metal, Longitudinal Grain Direction. Table 9:

		1CE	N383338	õ	5	5	80	∞	•	•	•	•	•	•	•	•	•	80	•	•	•	•	•	•	
		(9	.01 × 15d) 	-	ı	1	9.6	8.6	8.2	9.7	9.7	9.7	9.6	8.5	9.7	10.1	676	9.7	9.6	38	3	88	10.0	2	
			3	-	1	ı	_	-	-	-	1	1	1	1	1	ł	ı	ı		1	ı	ı		-	
		NO	% ABREA ITOUGER	ı	1	1	١	_	-	1	-	-	1	1	-	-	1	1	•	_	ı	,	ŧ	-	
	RESULTS	VIION	GAGE HTONEL	2.0	2.0	2.0	2.0	2.0	2.0	2.0	20	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2,0	2.0	2.0	2.0	
		ELONGATION	ž	8	80	80	10	6	10	6	=	0	10	6	6	10	6	10	10	10	10	0.	10	10	
		Δ	F tv (KSI)	58.8	59.1	59.9	58.2	58.3	1.65	58.9	58.8	1.69.1	58.6	58.7	58.3	58.8	58.8	58.7	58.7	59.1	58.4	58.4	57.9	58.2	
			F (KSI)	70.0	70.3	71.0	69.7	68.5	70.4	70.1	1.00	70.4	6.69	70.1	9.69	70.1	70.1	70.0	6.69	70.1	68.7	7.089	9.69	69.7	
	DATA		DNIGAOJ STAR M\NIVNI)	4 2	4 Z	4	0,006	0.006	0.006	0.006	0,005	Q.005	0,005	90010	0,005	0,006	0,005	0,005	Q.006	0,005	0.005	9000	0.006	9000	
	TEST C	ı	SOAK TII	Ą	4 2	4 2	¥ Z	ď	42	A S	¥ Z	4 2	Ą	٧	Z	٧V	4 2	4 2	¥	٧	¥ Z	ž	¥	₹Z	
E	LEN	SIONS	\$	0.50	0.50	0.50	0.50	0.50	050	0.50	0.50	0.50	0.50	0.50	050	0.50	0.50	0.50	Q.50	0.50	0,50	0,50	0.50	0.50	
	SPECIMEN	ENCH.	t OR DIA	2000	æ0°0	æ0°0	0.0615	0.0610	0.0614	0.0610	0.0614	0.0610	0.0620	0.0615	0,0600	0.0585	0.0605	0.0602	0,0610	0.0606	0.0615	0.0616	C.062r	0.0620	
			FORM	SHEET	- 1 St. 0.	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	
				2200	ZE0*0	Q.U32	0.06	900	90.0	90°0	970	900	0.06	a.06	0.06	900	0.06	900	a.06	0.06	90°0	900	900	(LOS)	13
		N	SPECIME I, D,	1	2	3	A1	A2	18	82	C1	C 2	10	02	E1	E2	F1	F2	61	G2	£	72	11	7 21	Varkor set

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Table 9: Room Temperature (70º F-75º F) Tensile properties of 2219-T87 Aluminum Alloy Base Metal, Longitudinal Grain Direction (Continued)

			Τ	Τ.	1	I					T	I	_	_	<u> </u>	_	ر,	.,	₁₀	ري ا		Г <u>.</u>	
	1.)	N 111 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	80	8	80	80	-	•	8	8	*	80	80	80	8	a	16	16	16	16	10	2	10
	4,,	1 1 1 1 1 1 1 1 1 1	6.9	6.6	9.6	9.7	8.6	8.6	8.6	86	8.6	9.6	īğ.	6.6	9.7	8.6	1	301	ı	11,1	ŀ	ı	Į.
		3		1	0.295		0,292		9920	1	0.319	ı	0.284	i	96270	,	ı	0.322	ı	0,329	ı	ı	,
	NO	V 187 % ^Bt V	i 1	,	,			,	1	1	-	ı	J	ł	ı	1	18	8	æ	3 8	_	-	1
RESULTS	NCITA	19V9 HT9N+1	2.0	20	2.0	2.0	2.0	20	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0.2	2.0
	ELONGATION		01	10	-	01	į	6	ļ	თ	1	10	1	10	i	11	8	8	10	1.1	11	10	ð
	Ŀ	7 7: <u>\$</u>	57.6	58.3	57.1	₹ 86	56.7	58.3	56.3	58.2	56. 8	58.2	57.1	59.2	57.2	59.2	55.7	54.9	55.8	55.2	58.0	57.2	\$7.5
		r - - (KS)	69.7	8.89	8.8	68.7	68.5	69.5	9.89	9.69	686.9	69.6	69.3	71.2	680	70.6	67.3	66.5	67.7	67.1	686.9	68.5	88,
DATE		MICIAO I TAR IM-MIMII)	0,000	0,005	a.005	0.005	0,005	0,005	0,005	0,005	0,006	0.006	0,005	0,000	Q.005	a,005	0,005	0,006	a.005	a.006	٧	NA.	\$
TEST DATA		SUOOH) WILMVOS	4 2	A A	۷ ۷	۸A	۸A	٧V	۲N	٩Z	NA	٧٧	۸۸	٧N	٧V	MA	۸×	Α̈́Σ	¥	ď Z	٧×	₽ N	¥
MEN	SIONS	>-	0.50	0.50	aso	0.50	0,50	0,50	a.50	0,50	a.50	0.50	a. 50	0.50	a.50	a.50	a. 50	a.50	0.50	0.50	0.5	. 30	3
SPECIMEN	TONL	0F 21¢	0.0620	a,0620	0.0620	a.0615	a.0620	0,0615	a.0630	a.0620	0.0625	Q.0620	0.0630	0.0615	0.0645	0.0634	a.0620	a.0623	Q.1247	Q.1256	Q.125	Q.126	Q.125
		₽ORV	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET								
		(HICKNE THICKNE OBICINA	0.06	a.06	a.06	90°D	a.06	900	a.06	0.06	900	0.06	900	900	300	900	Q.125	Q 128	Q.125	Q 125	Q 128	Q.125	Q 128
	į,	d T Zbf C#WE	וו	St.	¥	K2	.1	2	Σ	M2	12	N2	01	02		22	TAL-1	TAL-2	TAL-5	TALE	,	80	٥

D 0.2%OFFSET

Room Temperature (70º F.-75º F.) Tensile Properties of 2219-T87 Aluminum Alloy Base Metal, Longitudinal Grain Direction (Continued) Table 9:

											,					_				,					1
	4OF	FEREN	ЭH	12	12	8	3	91	16	=	=	-2	2	13	17	12	٣	۳	12	12	2	2	2	2	
	9	.01 × 19.	id)	_	1	10.5	10.4	í	10.0	1		68	35	8.3	8.4	9.7	11.3	9.7	ı	1	10.6	10.0	10.7	0,11	
		3		-	_	0.30	-	-	0.309	1		1	1		-		05.0	-	-	+	axo	0.313	096.0	0.344	
	NO	ABEA ITOUG	_	ı	1	ĸ	98	88	R	28.9	28.9	'	•	ł		ł	15	R	-	_	874	8'12	erae	e ve	
RESULTS	ATION	AGE HTƏN		20	2.0	2.0	2.0	2,0	2.0	d.1	3	20	22	2.0	2.0	2.0	2.0	ន	2.0	2.0	2.0	orz	2.0	2.0	
	ELONGATION	šę		5.6	9.5	10	1.1	12	12	16.4	15.1	13.5	13.5	13.6	13.0	12.0	7	7	13.5	11.5	12.5	12.0	11.0	10.5	
	<	1 _ ≥	(KSI)	53.83	54.45	6,38	56.8	58.4	57.6	57.3	5 6.5	53.6	53.5	1.38	53.9	3	56.0	56.1	16.33	56.44	56.3	17'99	**	9749	
		<u>.</u> 2	(KSI)	67,61	17.73	68.2	67.3	4.08	66.2	70.0	98	67.2	3,86	67.1	9.26	66.4	68.5	68.2	70.37	66.79	1.88	68.3	1.73	1.73	
DATA		ONI GA(3TAR IM∙NIV		Y 2	₹	0,006	0.006	0,006	0.005	ş	ş	9000	0,006	9000	9000	Q.006	0.006	0.006	ş	ş	9000	g.006	9000	0000	
TEST DATA	;	NIT MAI		¥.	٧×	¥	٧¥	¥	ş	Q.15	Q.15	ž	Ž	¥	ş	ş	ş	¥	ş	ž	ş	ž	ş	**	
EN	SIONS	3		Q.50	0.50	0.50	0.50	050	0.50	1	١	0.50	05.0	osto	050	050	920	0.50	0,62%	3.625	050	050	0.50	030	
SPECIMEN	(INCH)	- NO	DIA	Q.125	0,125	Q.1242	0,1240	0.3015	0,3018	Q.16	Q.16	0.50	05.0	050	050	0.50	Q.6240	95250	0020	9730	9.75	Q.78	Q.15	0,15	
		FORM	i		ЗНЕЕТ	SHEET	SHEET	æ.º	ہے	٤	2	یے	F	¥	F.	ہے	ی	ہے	2	ي	2	ي	-	ď	
		ACH) HICKNE BICINA	11)	Q.125	Q.125	0.125	0.126	0.50	050	9	0.50	0.50	050	020	050	o.so	a.625	0,625	978	Q.75	1,0	57	6.	1.0	FFSET
	N	oECIME	i IS	TCU-19-C	TCU-19-D	ALR-1	AILR-1	TALO	TAL-10	ş	₹	42	¥	N.	Ş	ž	ALR-1	ALR-2	TOUTEN	TCL-1948	14.1	14-2	7.47	TA-8	> 0.2% OFFSET

 Table 9: Room Temperature (70º F - 75º F) Tensile Properties of 2219-T87 Aluminum Alloy Base Metal,

 Longitudinal Grain Direction (Continued)

	NCE	983438	9	15	15	6	17	17	11	17	17	17	17	17	17	17	15	15	7	7
	(9.	(PSI × 10	-	-		-	9.2	6.5	9.6	1.6	10.0	9.5	9.9	9.6	10.0	10.1	-	_	_	-
		1	l	_	t		-	1	ì	ŀ	-	_	1		_	1	ł		1	-
	NOI.	% AREA TOUGE	24	25	30	_	_	_		ļ				-	_	1	23	23	_	_
RESULTS		GAGE LENGTH	1.0	1.0	1.0	ļ	2.0	2.0	2.0	2,0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	NA	ΑN
		*	10	10	10	1	15.0	13.5	14.0	15,0	14.0	10.0	10.0	10.0	10,0	10,0	12	12	10.0	9.0
		F (KS)	55.6	9'99	57.1	67.9	53.5	54.0	53.3	53.9	54.2	54.2	54,4	53,7	53.7	52.4	46,8	6.95	56.0	9:09
		F _{tu} (KSI)	8.79	8.89	69.1	72.0	9.59	9.39	65.2	9'39	1.99	8.99	67.4	0.99	65.8	65.0	69.1	69.5	0.89	71.1
		LO.ADIN BTAR (IN\NI)	NA	0.005	0.005	NA	0.005	0.005	9000	0.005	0.005	ാ0.0	0.005	0.005	900'0	0.005	0.005	0,005	NA	NA
DATA		я зчмзт №) зя ∪т	RT	RT	RT	RT	75	75	75	75	75	75	75	75	75	75	RT	RT	RT	ВŢ
TEST DATA	-N	ENVIRO MENT	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR
		SOAK TI	٧V	NA	NA	NA	NA	AN	NA	ΝΑ	NA	NA	NA	NA	ΝΑ	NA	NA	NA	ΑN	NA
SPEC:MENS	DIMENSION (INCH)	*	-	1	_	۷A	1	_	ı	1	1	-	ļ	_	-	_	05.0	05.0	ı	1
SPEC	OIMENSI (INCH)	OR DIA	0.249	0.25	0.27	٧A	0.505	905'0	0.505	0,505	0,505	905'0	905.0	0.505	0.505	0.505	0.50	05'0	0.125	0.125
		FORM	枟	4	PL	7	7	F.	7	۳.	7	ъ	Ы	7	ď	4	P	7	£	4
	SS	ORIGINA THICKNE (HONI)	1.0	1.0	1.0	0.1	1.0	1,0	1.0	1.0	1.0	1,5	1,5	1.5	1.5	1.5	2,5	2.5	2.5	4.0
	N	SPECIME 1.D.	ITL-1	L2-1	L2-2	AN	AN	٧V	A N	Ą Z	٧×	۸N	A S	₹ Z	A N	۸	AL25-1	AL25-2	۷ ۷	۸

◯ 0.2% OFFSET

Table 10: Room Temperature (70° F-75° F) Tensile Properties of 2219-187 Aluminum Alloy Base Metal, Long Transverse Grain Direction

98 G	13 J	Alloy Base Metal, Long TI SPECIMEN TEST DAT	Y Bass Metal, Long Ti	Hetal, Long Ti	JA 7	wsue.	erse Grain	n Directio		RESUL15				
Νł			CINCH					Δ	ELONGATION	ATION	NOI		(g	1OF
L D. SPECIM	(INCH) THICKN OBJUHN	FORM	r OR DIA	3	(HOUR SOAK TI	NIGAOJ 3TAA M·NINI)	F _{tu} (KSI)	F ₁ , (KSI)		GAGE HTAN3JI	^ AREA TOUGTA	3	.01 * (Sa) 3	11113131
4	a032	SHEET	2000	aso	٧	Ą	2.17	61.2	8	2.0	-	_	-	10
5	a.032	SHEET	0.032	a.50	4 Z	٧	71.0	58.7	80	2.0	1	_	-	10
9	a.032	SHEET	0.032	0.50	ş	۷ ۲	72.3	5.65	8	2.0	_	1	ł	10
٨.	0.06	SHEET	a.0602	Q.50	Ą	0.005	71.1	920	8	2.0	1	1	19.0	•
A 2	0.06	SHEET	0.0604	0.50	NA	α.005	70.6	58.8	10	2,0	1	1	9.8	80
18	0.06	SHEET	0,0610	0,50	¥	0,005	70.1	58.2	8	2.0	1	ı	10.	•
82	0.06	SHEET	0.0606	0.50	Y.	0.005	70.7	8.82	6	2.0	ı	ı	9.6	80
5	900	SHEET	0.0610	0.50	NA	0,006	70.3	58.2	6	20	ı	ı	9.6	•
8	0.06	SHEET	0.0610	0.50	A A	0.005	70.2	58.2	10	2.0	-	1	676	80
5	0.06	SHEET	0.0612	0.50	٧	0.006	70.5	58.1	80	2.0	i	1	9.9	8
02	98 0	SHEET	0.0615	0.50	Ą	0.005	2 0,3	58.0	10	2.0	ŀ	_	9.7	8
E1	90.00	SHEET	0.0595	0.50	ž	0.006	70.3	58.5	6	2.0	-	!	9.8	8
E2	90.0	SHEET	0,0505	0.50	¥	0.006	70.3	58.7	10	2.0	_	1	6'6	8
F.1	0.06	SHEET	0.0600	0.50	4	a 005	گ 1	58.4	6	2.0	1	1	9.7	8
F2	0.06	SHEET	0.0600	0,50	4	Q.00E	70.2	58.4	10	2.0	_	ı	9.7	8
19	0.06	SHEET	0.0606	0.50	ş	g.205	70,3	58.2	11	2.0	1	-	6.2	80
62	0.06	SHEET	0.0606	0.50	¥	0,006	70,3	586.2	10	2.0	_	-	19.0	85
Ŧ	900	SHEET	0.0615	0.50	ş	3,006	ď	57.6	10	2.0	_	-	9.4	•
£	0.06	SHEET	0.0610	0.50	ž	9000	72.4	58.1	11	2.0	i	١	9.7	
	900	SWEET	0.0620	0.50	¥	Q.006	68.6	57.2	10	20	•	_	8.9	
12	0.06	SHEET	0.0620	0.50	¥	0.036	9.00	57.1	=	20	ì	ı	976	•
4														

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Table 10: Room Temperature (70º F-75º F) Tenaile Properties of 2219--787 Aluminum Alloy Base Metal, Long Transverse Grain Direction (Continued)

Г	1734			Π		_			_		Γ						2	9	5	•	9	91	•
<u> </u>	3.31	11 EE 11 E 17	1	Ļ	80	•	•	•	-	•	-	•	•	•	•	•	<u>~</u>	-	-	٠	-	_	-
	⁽ 9	FSI + 10°	9.6	8.9	2	10.2	10.3	2	9701	-	6.8	3.8	0.01	9.7	2.2	10.0	1		-	1	0,11	1	11.8
		د	,		3,299	1	0.328	ł	12270	-	0.306	+	0.280	1	-	,	-	,	ł	ŀ	0,328	١	0,338
	NO	A1fiA iTOUCII	,	1		-	-	-	-	-	1	-	1	+	-	ı	1	_	1	1	-	ı	-
RE SULTS	ATION	GAGE FNGTH	22	ន	20	2.0	2.0	2.0	2.0	2.0	2,0	2.0	2.0	2.0	2.0	2.0	2.0	20 .	20	2.0	2.0	2.0	2.0
	ELONGATION	e [®]	0.	=		=	ı	12	-	10	1	1.1	-	11	1	10	6.	10	10	•	8	10	6
	•	4	57.2	57.1	56.4	57.2	8795	57.6	2'99	ı	56.3	57.4	£.395	57.6	696	57.7	5.8.3	54.1	58.1	5442	53.4	56.6	56.5
		ار (KSJ)	808	678	98	7.000	FB. 6	70.0	66.2	נמ	68.3	70.0	66.8	70.6	69.7	20.3	70.4	70.3	202	67.9	9790	988	98. 1
DATA		DNIGAOJ STAR IM-NIVII	8	Q UDS	0000	0,006	0,006	9000	9000	900'0	0,005	900'0	0.005	900'0	900'0	900'0	NA	P&A	٧N	2000	9000	900'0	0.005
TEST [MT AAG (HCURS	Ą	¥	¥	¥N	٧V	NA	٧N	VN	¥	N.	NA	٧N	٧N	VN	VN	VN	٧N	MA	¥N4	٧N	NA
SPECIMEN	SIUNS	3	050	0.50	057	050	050	0.50	05.0	0970	05.0	080	0510	09'0	05'0	050	020	050	ogro	05.0	050	09'0	050
SPECIMEN	(INCH)	1 96 A10	0.0620	0.0618	07900	0,0615	97.00 D	0.0615	0.0620	0,0615	029010	0.0615	0.0630	07900	0 1084 0	g.0632	Q.125	Q.125	Q.125	0.0625	0,0628	0.1252	0,1258
		FORM	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET
		DRIGINE THICKNE (INCH)	1 8	900	90'0	8	900	90°0	300	0.06	900	300	0.06	0.06	900	300	Q.125	Q.125	Q.125	Q.125	0.125	0,125	Q.125
	N	I' D' S b ECI W E	5	rg Pr	r,	K2	۲1	77	M1	M2	. N	N2	10	02	P.1	2	10	11	12	TAT-1	TAT-2	TAT-6	TAT-6

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Table 10: Room Temperature (70º F-75º F) Tensile Properties of 2219-T87 Aluminum Alloy Base Metal, Long Transverse Grain Direction (Continued)

ſ		3/14			<u> </u>	₁	16	_	_		11	17	17	11	2	3	9		2	2	36	•	16	~
-		301	REFEREN	3	3	16	=	:	=	17	-	_	_	-					_	-	<u>=</u>	-	-	\dashv
		⁽ 9	(621 × 10.	10.6	Į.	1	10,7	į	l l	3	8.4	0,01	10.0	98	876	11.4	i	1	-	1	-	-	1	ğ
			מ	-	-	-	Q.312	ı	-	-	-	1	_	-	-	-	1	-	1	-	-	*	-	923
<u> </u>		NO		u	K	2	11	22.5	20.1	ı	-	ł	1	1	31	82	23	ı	7	13	1	1	1	11.7
(2021)	RESULTS	MOITA	GAGE LENGTH	2.0	2.0	2.0	2.0	3	0.1	07	0.2	07	2.0	97	2.0	970	3	ı	3	3	0,2	20	92	ន
		ELONGATION	ok	10	10	6	6	12.9	13.9	19.0	10.0	12.0	070	31	7	7	•	-	7	7	40		7	3
		2	r ty (KSI.	56.2	238	58.3	57.9	56.1	54.4	64.5	54.7	82.8	54.4	52.6	56.0	56.1	54.7	54.2	56.7	E6. 0	54.2	56.7	56.5	3
			F _{tu} (KSI)	68.9	68.5	70.3	70.3	66.7	67.4	67:4	0.0	200	67.3	GE.7	68.3	66.3	87.9	72.0	0.00	3.00	88.5	2.5	68.0	3
	DATA		ONI DAOJ TAR M\NINI)	0,006	9000	9000	90070	ş	Ž	9000	0,006	0,006	0,006	0,006	9000	9000	¥	ş	9000	0,006	0,006	0.005	0,000	9000
	TEST C		SOAK TII	¥	ş	ž	٧¥	0.15	0.16	ž	¥	¥	ž	¥	¥	¥	Ş	¥	¥	¥	ş	ž	¥	ş
	EN CONC	SIONS	3	0.50	050	0.50	0.50	-	ı	0.50	0.50	0.50	OFFO	0.50	0,50	040	-	ş	-	,	O.E.O	0460	O.Eo	3
	PIMENSIONS	(INCH)	t OR DIA	0,1246	Q.1244	0.3008	0,3003	91.0	91.	05.0	020	0.50	0.50	0.50	0.6286	0.6240	0.240	¥	0.25	828	950	950	050	213
			FORM	SHEET	SHEET	¥	, L	2	_	, P	7	_	4	-	2	7	-		-	4	4	d	4	4
			ORIGINA ORIGINA	Q.125	Q.125	0.50	OE0	0.50	0.50	050	0.50	950	950	050	0,625	0.625	10	33	20	3	20	20	9	3
		N:	SPECIME	AITR-1	AITR-2	TAT-8	TAT-10	7	¥	MA	ş	Ş	5	\$	ATR-1	ATR-2	1-11	ş	판	T L2	AT-1	AT-2	AT-3	TA-20

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Table 10: Room Temperatura (70º F-75º F) Tensile Properties of 2219-T87 Aluminum Alloy Base Metal, Long Transverse Grain Direction (Continued)

				E SEBO		H II GIISAG		מושנות	Only base metal, tong Hensterse Utain Direction (Comminden)	nen'				
			SPECIMEN	EN	TEST	DATA				RESULTS				
N			(INCH)	SIONS				<u> </u>	ELONGATION	ATION	NO		⁽ g	101
SPECIME I, D.	INCH) LHICKNE DBIGINS	FORM	1 08	*	OAK TII	ONDOO. STAR M\NI\NI	r, 15 15 15 15 15 15 15 15 15 15 15 15 15	7 " 2 <u>8</u>	jum	30AD HTDN3	ABEA ITOUGH	3	.01 × 10. 1	118311
	. 2	یے	Ka	050	5	§	88.4	2,2	980	1 2		0.336	10.5	7
TA:4	0.1	ي	Q.75	950	\$	0,006	88,	3	7.5	20	11.9	0.327	10.3	2
TA-19	1.0	بي	Q.15	050	Ž	0,000	67.4	53.8	7.5	2.0	15.4	0.366	11.4	2
3	0,1	4	0.506	-	Ş	0.005	67.3	530	13.0	20		-	9.5	17
\$	ទ	æ	9050	,	¥	0,006	88.3	3	15.0	20	1	1	2	12
\$	0,1	يے	90970	1	4	0,006	6,38	53.1	15.0	2.0	ı	1	8.4	11
≨	1.0	یے	90970	1	A.	0,006	67.2	53.6	12.0	97	ı	-	8.6	11
į	0,1	ď	9050	,	X	0,006	7,38	53.4	12.0	ន	ı	1	9.7	7.1
AL-1	1.0	یے	2305.0	3	4	9000	8.6	36.5	ō	20	16	1	,	s.
ALG	2	2	0.3770	3	ş	9000	8 6.7	5,55	01	92	13	1	1	s
TA:	1,28	<u></u>	00970	-	ş	0,006	7780	2795	10.5	2.0	1	1	ı	13
TA-2	1.25	'n	600	ł	Ž	0,005	9799	56.8	10.0	2.0	_	-	-	13
· 1-4	1.26	4	00970	ı	٧N	9000	70.1	673	10.5	2.0	16.0	_	1	14
ĭ	2.0	4	9050	-	XX	9000	8799	512	10.0	072	1	_	_	17
¥	91	1	90970	,	ş	9000	64.4	52.3	10.0	2.0	1	-	19.1	17
ž	מ	ی	90%0	ı	44	0,000	986.6	623	10.0	072	+	_	10.3	17
ž	27	-	909'0	1	MA	9000	66.3	52.6	10.0	2.0	_		10.1	17
Ş	2	al.	90970	ı	¥	9000	3	52.6	10.0	2,0	ı	_	10.1	17
ATZ-1	572	.	040	950	W	9000	979	56.3	01	0.5	15	_	_	15
AT#2	2.5	4	970	O.S.O.	YN	9000	m. 7	586.3	10	2.0	94	-	ŀ	15
\$	2.5	N.	Q.126	+	ş	¥	67.6	56.3	8.0	ş	1	_	_	7
ş	\$	٠	0.135	1	ş	ş	E.S.	ag S	2	ž	ı	ı	1	7

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Table 11: Room Temperature (70º F-75º F) Tensile Properties of 2219-T87 Aluminum Alloy Base Metal, Short Transverse Grain Direction

		1CE	13B	3138		7	
		(g		(ISa) B	1	1	
				3	1	1	
	٠,			AA % J0∃ฅ		1	
	RESULTS	ELONGATION		CENG	Ą	NA	
		ELONG		%	5.0	3.0	
		Æ	7 '	ry (KSI)	55.5	57.0	
			ı	ارن (KSI)	64.8	62.4	
	DATA		3T,	JAOJ AA (INII)	Ą	¥ Z	
- / /	TEST DATA		NIT ; SAU	(HOI	Ϋ́	٩	
	MEN	ENSIONS (H)		`}	,	í	
	SPECIA	(INCH)	-	O O P I A	Q.125	0.125	0.2% OFFSET
				FORM	4	۳	Ø 0.29
			KNE	ORIG SIHT (INC)		0,	
		N	3WI	SPEC 1. D.	٩X	٧	

Dry Ice and Acetone (-110⁰F) Tensile Properties of 2219-T87 Aluminum Alloy Base Metal Table 12:

			10,000	(2)										
			SPECIAL PROPERTY OF THE PROPER	ECIMEN MENSIONS	TEST DATA	ATA				RESULTS				
N			(INCH)	SIONS				Æ	ELONGATION	ATION	NO		(9	ICE
3W	INE					3.		7					١٥.	ve:
ECI D.	1CK 1CK 1CK	FORM	- ₈	3	10n V	DAC TAR NIV	F _{tu}	F.	%	AGE NGT	aaA DUG:	3	× IS	434
	łΤ		DIA				(KSI)	(KSI)					(b)	38
٧٧	Q.50	A	Q.16	_	0.15	Ą	73.5	1.4	15.6	1.0	27.9	-	_	11
¥	020	ی	0.16	_	0,15	ď	73.8	2.6 5	14.7	1.0	28.9	ı	ı	11
٧	0.50	ď	Q.16	-	Q.15	ş	72.3	58.0	12.9	1.0	24.5	ŧ	ł	11
4 X	U.50	4	Q.16		0.15	٧	72.1	58.5	13.8	1.0	19.1	-	_	11
			0.2% OFFSET											1
		NO A	LONGITUDIN	AL GRA	JDINAL GRAIN DIRECTION	NOI								
			LONG TRANS	VERSE G	IANSVERSE GRAIN DIRECTION	ECTION								

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Table 13: Liquid Nitrogen (-3200 F) Tensile Properties of 2219-TB7 Aluminum Alloy Base Metal, Longitudinal Grain Direction

				A COLO	Sept Mark	CITOY DOSS METAL, LONGINUMAI GIBIN DIRECTION			cuon					
			SPECIMEN	AEN	TEST [DATA				RESULTS				
N			(INCH)	SICINS				2	ELONGATION	ATION	NO		اوا	40
I' D' SPECIME	(INCH) THICKNE (INCH)	FORM	- 00 G	W	HOURS	OADINC STAR M·NIVII	T. SE	\ <u>\$</u>	٦.	30 A 0 HT0N3	ABEA FDUCTI	.a	,01 × 18d 3	HEFBEN
1474	2	SHEET	0,1242	053	ž	8	8	61.1	22	ង		83	11.4	9
AICK1	Q.125	SHEET	Q.1236	0.50	¥	0.005	846	67.0	=	2.0	23	,	10.7	m
¥	0.50	R.	Q.16	ļ	Q.15	ş	82.8	67.5	15.6	1.0	28.9	1	-	=
¥	0.50	R	0.16	-	0.15	ş	83.8	96.3	16.4	0,1	2	,		ء
ş	05.0	P.	ogo	05'0	Į	0.005	ž	67.5	15.5	2	ı		19.6	:
ž	0.50	P.	050	050	≨	0,000	0,76	3	16.5	2		1	1	=
ş	0.50	R	0.50	050	¥	0,005	BALS	86.5	70	20	1	ı	11.8	=
ş	030	P	050	050	ş	20073	ž	3	15.0	2	1	1	10.3	=
ş	0.50	P.	050	osto	¥	0,005	823	63.7	17.0	07	1	1	10.4	=
ALN-1	9628	P.	Q.6288	ഗ്യാ	¥	3000	5.3	67.2	ð	3	R	23.	12.0	~
ALM-2	0.626	F	97290	050	ş	0.005	38	67.0	ð	2	8	1	13.8	6
ITL-2	1.0	J.	0240	-	ş	ş	3	980	=	2	R	,	1	9
14.3	1.0	u	0.75	050	ş	0,005	83.3	62,7	3	2.0	ĸ	9020	3	2
141	1.0	L	a.75	050	MA	0,005	84.5	9799	15.0	22	25.4	0.333	11.5	2
TA-9	1.0	A.	Q.15	0.50	¥	0,005	82.7	66.3	12.5	2.0	9792	0.22	11.7	7
TA-10	1.0	R.	ars	050	NA	0.006	82.6	6790	3.11	2.0	1.12	0.33B	12.0	2
ş	1.0	4	9090	_	¥	0,006	81.3	6729	Q.71	2.0	-	***	12.0	17
¥	1.0	R	0.505	_	ş	3000	81.1	7739	0.71	0.2	_	-	3.8	"
ş	1.0	, P	0.506	_	ž	9000	81.1	62.5	0.77	07	-		12.7	17
¥	3	7	979	_	¥	9000	86.0	1.388	0.71	0.2	-	ı	19.7	17
ş	9	.	0.505	_	¥	3000	81.7	9799	36.0	2.0	ı	-	10.	7.
2	0.2% OFFSET													

D 0.2% OFFSET

Table 13: Liquid Nitrogen (-320°F) Tensile Properties of 2219-T87 Aluminum Alloy Base Metal, Longitudinal Grain Direction (Continued)

		ICE	REFEREN	15	15	5	15	17	7.	17	17	17
		⁽ 9	.01 × 10.	1	1	-	1	11.2	11.3	10.6	10.6	10.7
			מ	-	-	-	ł	1	-	-	ı	-
		NO	% AREA TOUGER	24	21	19	18	-	1	ł	ı	ı
	RESULTS	ATION	е≽с НТЭИЭЈ	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
,		ELONGATION	şę	12	11	12	13	15.5	14.0	14.0	13.0	13.0
		, J	F _{ty} (KSI)	68.3	68.0	70.0	70.5	66.5	66.0	66.7	640	64.5
			F _{tu} (KSI)	86.4	86.4	86.8	88.9	84.6	84.3	83.1	84.6	83.5
	DATA		DUI QAOJ STAR (INVINM)	9000	9000	9000	9000	0,005	9000	90 00	0.005	a.006
,	TEST DATA		SOAK TII	₹	¥N	٧V	٧V	NA.	NA	¥N	NA NA	NA
,	CIMEN	SICINS	*	1	-	0.50	030	1	ì	1	1	1
	SPECIMEN	(INCH)	t OR DIA	0.25	0.25	0.50	0,50	0.506	0.505	0.506	0.506	0.505
			FORM	P.	F	4	4	. F	ی	یے	ہے	7
			ORIGINA THICKNI ORIGINA	1.0	1,0	2.4	2.5	1,5	1.5	1,5	1.5	1.5
		N:	SPECIME	53	3	AL26-3	AL26-4	٧×	ş	4	ک	ş

D 0.2% OFFSET

Table 14: Liquid Nitrogen (-320°F) Tensile Properties of 2219-T87 Aluminum Alloy Base Metal, Long Transverse Grain Direction

		ICE	11.1	13738	•	•	<u></u>	•	=	2	=	:	2	=	•	-	2	2	=	=	2	•	~	*	~
		⁽ 9	١٥.	* ISd) 3	5	5	121	11.6	 	5	13.	3	2	124	ũ	5.	١,	١.		1		3	5	73	5
				3	ā	6.13	-	-	,	1	-	,	١	1	,	,	 	ł	1	,	ı	3	Ŋ	9	3
		NO		3₽ A # UG3A		,	R	X	225	1	1	'	1	1	2	2	*	2	1	ı	-	3.	3	3	5
	RESULTS	ATION		GAGI	2	ន	22	92	2	2	ន	ន	3	2	2	ន	3	3	2	2	2	92	ន	22	2
Š	·	ELONGATION		Ąģ	٥	6	13	12	3	11.5	11.6	3	11.0	12.0	12	12	•	•	12	=	12	3.5	20	10.0	11.0
Danie Charles		4	7	f ty (KSI)	71.4	71.3	67.0	3	3	67.2	3	3	92.6	67.4	-	38	B 3	68.0	96.3	<u>.</u>	. d	3	67.3	1.20	3
				f. (KSI)	88.4	*	87.2	87.0	81.9	ž.	ž	7.23	34	3	3	73	17.0	67.0	98.0	3		3	ī	9	2
Complete Complete	DATA	1	31	GAOJ 'AR NNNI)	800	600	0,000	0,005	\$	g.000	0,000	900	0.006	0,000	0.006	2006	9000	0.006	9000	0,006	0,006	900	9000	0,006	0,006
,	TEST			HOC 204K	2	§	ş	ž	Q.15	ş	ş	\$	ş	ş	ş	ş	\$	Ş	ş	ş	\$	\$	4	V.	¥
,	EN	SIUNS		\$	35	050	950	050	ı	3	3	3	050	050	35	3	-		33	350	3	3	3	3	950
	SPECIMEN	(INCH)		OR OIA	0.000	0,0806	0.1246	Q.1244	a16	33	950	3	0,50	950	072370	900	82	ş	3	3	3	5	K	Q.15	a.16
				FORM	SHEET	SHEET	SHEET	SHEET	یے	a.	a	, F	4		4	,	4	€	ę.	ď	ď	٠	at	4	¥
			N)	ORIG THICI (INCH	900	90'0	0,126	Q.125	920	950	S	950	020	050	9290	823	9	9	2	2	3	3	3	3	97
	-	N	IWE	.a.ı .a.ı	ž	ş	AITN-1	AITN-2	4 2	ş	ş	Y.	¥¥.	¥	ATIN-1	ATIN-2	12.1	T2-2	AT-4	AT4	AT.4	TA-16	91.₹1	TA-21	14.2

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REPRODUCIBILITY OF THE QRIGINAL PAGE IS POOR

Table 14: Liquid Nitrogen (-320^oF) Tensile Properties of 2219-T87 Aluminum Alloy Base Metal, Long Transverse Grain Direction (Continued)

		ICE	REFEREN	2	2	9	11	11	11	17	1.7	14	13	13	15	15	17	11	17	13	1
		(9	(b21 × 10.	+	_	_	11.3	10.7	11.3	_	ı	_	Ι	-	-	1	<i>1</i> 13	11.1	11,0	10.6	10.5
			מ	1	-	1	1	-	1	ı	1	1	ı	1	_	1	-	ŀ	-	1	•
		NO	% AREA	14	15	23	1	-	1	-	ı	18.0	-	ı	17	6	1	ı	1	ł	_
	RESULTS	ATION	ар д а НТаизЈ	2.0	2.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2,0
ngan'		ELONGATION	3°	6	12	1	15.0	15.0	15.0	15.0	15.0	9.5	10.5	10.0	13	6	12.5	12.5	12.0	12.5	12.5
base metal, Long Hallsverse Orall Differior (Commuted)		Æ	r, y (KS!)	6.39	66.5	66.0	64.5	64.3	7	8	61.8	66.1	2.73	67.8	68.5	6'99	63.8	63.0	83.8	829	8.29
שוני היופרנו			F _{tu} (KSI)	84.6	85.6	85.4	83.1	83.2	82.6	82.3	82.2	79.4	85.9	85.7	88.4	84.5	82.4	82.7	82.4	82.9	82.9
isterse or	DATA	!	DUIDAOJ BTAR IM\UI\UI)	0.005	0.006	4 Z	0.006	0.006	0.006	0,006	g000	0,006	9000	900'u	0.006	0,006	0.005	0,006	0,006	0000	9000
דחווא וומו	TEST (SOAK TIN	0,25	Q.25	٧	Ą Z	42	٧Z	ď Z	₹ Z	٩٧	٧×	¥	٧V	٧	₹ Z	4 2	A S	¥ Z	٧N
מספ ווופנמו,	CIMEN	CH)	W	0.50	0.50	ł	-	,	1	ı	1	1		1	0.50	020	1	١	-	-	_
9	SPECIA	(INCH)	t OR DIA	0,3746	0,3756	0.249	a.506	0,506	0.506	0.506	0,506	0.500	Q.500	0.499	020	090	0.506	a.506	0.506	0.506	0°206
			FORM	낦	یے	یے	2	ہے	2	4	2	2	یے	₹	یے	e'	4	ی	æ	ď	ď
			ORIGINA THICKNE (INCH)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	U,	1.25	1.25	1.25	2.5	2.5	1.5	1.5	1.5	1.5	1.5
		N	SPECIME	AL-3	AL-4	ITT-2	ž	A S	ž	¥	¥	A-2	TA-3	TA-4	AT25-3	AT26-4	¥	ž	¥	₹ Z	¥
- (<u> </u>	<u> </u>	<u> </u>	<u> </u>	L	l	L	L	L	L	L	<u> </u>	L	<u> </u>	L	L.,	

D 0.2% OFFSET

Table 15: Liquid Hydrogen (-4230F) Tensile Properties of 2219-T87 Aluminum Alloy Base Metal, Longitudinal Grain Direction

									A	A	•			A	A						A	A	
	30	изивави	õ	ō	2	2	9	2	6	6	36	16	91	=	=	17	=	2	=	:	n]
	ا ا	,01 × 18a) 3	-	ı	1	-	-	1	10.9	121	11.7	12.0	10.6	-	1	1	10.6	11.4	1	1	10.8	3	33°E
		a		-	 	-	1	l	0.36	1		-	1		-	-	ı	ł	1	1	9670	ı	TESTED IN HELIUM GAS AT -423°F
S	NC	* ABREA ** ABREA ** ABREA				-	i		R	u	23	2	2	28.5	27.5	1	-	1	I	ı	12	Z	- FELIUM O
RESULT	ATION	30A0 HTƏN31	20	62	2.0	20	2	3	1	١	2	3	3	3	1.0	072	0.2	. –	-	972	-	-	STED IN
	ELONGATION	જ	16	91	91	ã	81	11	1	1	15	16	11	20.4	17.3	13.0	12.0	ŧ	-	13.0	-	-	Ä
		چ څ <u>څ څ</u>	76.0	73.4	8 8 9	73.2	22.5	74.8	71.3	39. 5	680.0	8.88	21.3	77.5	72.8	672	72.1	97.9	121	1.0%	70.3	12.1	
		F _{tu} (KSI)	102.3	101.5	101.8	98.7	98.6	7:38	738	93.9	96.4	1.76	100,1	102.0	96.1	1009	100.4	99.0	98.5	-	92.1	93.8	GAGE
DATA		ONIGAOJ STAR (IM·NIVII)	₹2	٧	Ą	42	٧	¥	0,006	0,006	a.005	0,006	0,006	AN.	ş	0,006	9000	0.005	0,005	0.005	a.005	0,006	STRAIN
TEST		SOAK TIN	₹2	4	¥	ĄN	Ę	¥	NA	¥	0.25	8228	0.25	Q.15	0,15	¥	¥	¥	NA	¥	¥	¥	OBTAINED BY STRAIN GAGE
SPECIMEN		ķ	0'20	050	0510	0.50	0470	05.0	0.50	0.50	0.50	0.50	050	-	-	0.50	0.50	0.50	0.50	0.50	0.50	0.50	Fty OBTA
SPECIMEN	(INCH)	t OR DIA	2500	æ0°0	æoro	0.125	0.125	Q.125	Q.1246	0,1240	0.0627	Q.1248	0.3019	Q.16	Q.16	0.50	0.50	0.50	Q.EO	Q.EO	0,6258	0.6256	, L
		FORM	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	L	P	٦	J.	L	4	R	R.	F	E.	
		ORIGINA THICKNE (INCH)	2000	2500	0,032	0.125	0,125	0,125	Q 125	Q 125	Q.125	Q.125	0.50	0.50	0.50	0.50	050	050	050	050	Q.625	0,625	0.2% OF FSET
	N	I' D' Sbecime	ĸ	92	82	31	æ	Ø	ALH-1	ALH-2	TAL-3	TAL-7	TAL-11	¥	≨	ş	\$	ş	ş	ş	ALH-1	ALM2	A

Table 15: Liquid Hydrogen (-4230F) Tensile Properties of 2219-T87 Aluminum Alloy Base Metal, Longitudinal Grain Direction (Continued)

			SPECIN	1EN	TEST DATA	DATA				RESULTS				
N			UIMENSIONS (INCH)	SIONS		t :		Ŀ	ELONGATION	ATION	NO		(₉ ,	ACE
SPECIME I. D.	ORIGINA THICKNE (INCH)	FORM	t OR DIA	W	(HOURS	LOADINC STAR (IN/IN/MI)	F _{tu} (KSI)	r _{ty} (KSi)	%	САБЕ СЕИБТН	% AREA ITOUGBR	ח	(PSI × 10'	иененеи
TA-5	1.0	ď	0,75	020	A S	900'0	98.9	68.1	16.5	2.0	20.0	0.340	13.9	2
TA-6	1.0	N.	a.75	020	A N	3000	0.66	0.69	16.5	2.0	18.5	0.387	14.6	2
TA-11	1.0	2	Q.15	020	۸N	a.006	98.4	68.9	15.0	2.0	13.0	0.348	13.4	2
TA-12	1.0	L	0,15	097	¥.	900°0	98.6	1	15,5	2.0	14.6	0.388	١	2
¥	1.0	Æ	0.505	_	AN	0.005	97.3	71.0	_	_	١	ı	12.2	17
4	1,0	R	0.506	-	A A	900°0	97.8	71.0	17.0	2.0	-	-	11.7	17
AN A	1.0	Ą	0,505	-	NA	0.006	97.6	71.3	19.0	2.0		١	11.9	17
٧¥	1.0	Ja .	0.506		NA AN	0,006	97.8	72.4	-	1	1	ı	11.7	17
٧٧	1.0	f.	0.505	-	NA	0,005	98.5	72.4	19.0	2.0	1	1	11.8	17
AL28-5	2.5	R	0.50	020	NA	0.006	104.9	74.4	11	2.0	١	ŀ	ļ	15
AL25-6	2.5	A.	0.50	a.50	NA	0,005	105.3	74.0	11	2.0	-	١	i	15
NA	1.5		a,506	_	NA	0,005	101,5	71.9	15.0	2.0	ı	1	11.8	17
NA.	1,5	j.	0,506	-	NA	0,006	101.6	73.0	16.0	2.0	ı	ı	11,1	17
٧٧	1,5	R.	0,506	-	NA	0,006	102,4	73.1	15.5	2.0	J	ı	ı	17
٧×	1.5	2	0,506	_	NA	0,006	102.1	72.4	16.0	2.0	_	1	ı	17
¥	1.5	F.	0.506	-	NA	0.005	102.4	73.5	16.0	2.0	_	_	10,7	17

D 0.2% OFFSET

Table 16: Liquid Hydrogen (-423ºF) Tensile Properties of 2219-T87 Aluminum Alloy Base Metal, Long Transverse Grain Direction

											◬	A										◬	<u> </u>
	40	и н г г в г и	2	<u>o</u>	0	8	8	ō	o.	2	3	3	16	16	16	16	17	17	17	11	41	11	
	1,	9.01 × 1Sa) H	1	1	ı	120	140	ı	ı	1	11.2	11.0	121	11.8	11.0	10.9	10.3	12.2	11.6	ŀ	١	-	,
		د	,	ł	1	0.341	-	1	l	1	_	-	-	٠	-	-	_	_ ^	-	-	-	-	1
S	N(» ABEA % ABEDUCTIC	1	ı	1	+	1	1	1	1	22	19	19	20	17	16	-	-	1	١	-	22.5	35
RESULTS	ATION	3AGE HTBN31	2.0	2.0	2.0	1	1	ร	20	20	-	-	2.0	2.0	2,0	2.0	2.0	2,0	2.0	2	0.2	0,1	2
	ELONGATION	7.5	91	15	13	1	1	7.	1	7	1	-	13	91	14	15	13.5	13.5	13.5	14.0	13.6	17.3	15.6
		, , , , , , , , , , , , , , , , , , ,	74.8	73.2	75.3	73.3	74.4	76.9	75.5	ğ	71.9	71.4	67.2	71.2	824	72.8	22.9	71.9	72.8	1	-	64.0	86.5
		F. (KSI)	102.1	101.8	2.08	7.86	101.6	183.2	102.4	7.281	8.86.8	89.3	87.8	101.3	101.8	101.5	104.0	101.5	0,101	6. 101	102.9	96.1	828
DATA	1	DUIDAO I TAR IIM∙NIVII)	₹ Z	ž	ž	0000	0000	¥ 2	Ž	ş	0.006	0,005	90070	0,005	0.005	9000	0.006	0.005	9000	9000	9000	ş	¥
TEST		SOAK TIM	ş	ď Z	ž	ž	₹ 2	ş	ş	ž	¥2	4	9270	9720	9270	9270	¥	¥	¥	ş	4	0.15	2.15
SPECIMEN	SIONS	\$	020	050	9250	050	S	050	0.50	8	050	020	050	0.50	050	050	050	050	oso	050	970	_	'
SPECI	DIMEN	- 0 A 4	0.032	0.032	0.032	0.0620	0.0636	Q.125	Q.125	a.128	0.1247	0.12:98	0.0624	a.1251	073000	0,3011	050	050	050	950	05.0	Q.16	a.16
		FO R ₹	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SMEET	SHEET	SHEET	2	ř.	ہ	a.	ہے	æ	ی	¥	ہے
		GRIGIANI THICKUE ORIGIANI	0,032	25010	2000	900	0.06	Q 128	Q.125	Q.125	Q.125	Q.125	Q.125	0.125	0.50	050	050	050	0.50	050	950	937	Oge
	N	F D' RECIMEN	R	8	8	ž	¥	ਨ	19	ĸ	ATH-1	ATH-2	TAT-3	TAT-3	TAT-11	TAT-12	¥.	4	¥	ş	ş	ş	ş

0.2% OF FSET

F_{ty} OBTAINED BY STRAIN GAGE

TESTED IN HELIUM GAS AT 423°F

Table 16: Liquid Hydrogen (-4230 F) Tensile Properties of 2219-T87 Aluminum Alloy Base Metal, Long Transverse Grain Direction (Continued!

				A																			
	CF	НЕ ЕВЕИ	٣	3	s	s	15	15	2	~	2	2	2	17	17	17	11	41	13	13	71	71	
	¹g	(b2l × 10.	12.4	13.1	ı	-	_	-	-	5 71	14.2	14.4	271	12.5	12.6	221	8711	13.3	ı	ı	-	ı	
		3		1	1	_	-	_	-	697	386	1.05.	38 6.	_	-	-	1	+	-	ł	-	1	
	NO	A BREA TOUGEN	16	16	12	7	ı	-	١	11.6	ž	13.5	231	١	ł	1	١	-	1	1	18.0	28.0	
RESULTS	ATION	30A0 HTON3J		ı	2.0	20	2.0	2.0	2.0	97	07	2.0	2.0	i	2.0	2.0	2.0	2.0	20	2.0	2.0	ล	
	ELONGATION	e\$	1	1	11	13	1.1	11	11	12.0	14.5	13.0	9 E1	-	15,0	13.0	0761	13.0	13.0	12.0	7.0	578	
	4	F T	ı	71.4	71.7	20.8	6789	2'89	67.9	272	7.17	70.2	274	72.4	121	20.0	7.07	223	₽'89	828	91.	75.5	
		F _{tu} (KSI)	3	1	100.7	101.0	100.0	100.8	100.7	2,101	100.5	98.7	100.8	100.2	100.5	8796	S'86	1001	0'86	1001	1.101	6TEO S	
DATA		LOADING 3TAA IM·MI\NI)	0,006	0,006	0.006	0.006	0.006	900'0	9000	9000	9000	9000	900°0	9000	900'0	9000	9000	9000	900°0	9000	9000	9000	
TEST [1	SOAK TIN	¥	Ą	0.25	9270	V	٩×	NA	₹2	42	٧V	٧N	VN.	¥	٧N	¥N	٧N	¥	YN.	٧V	¥	
AEN	CINCH)	*	050	0.50	0.50	0.50	050	0.50	0.50	050	050	0,50	0.50	_	1	_	ı	+	ı	1	-	1	
SPECIMEN	CINCH	t OR DIA	09290	0.6250	0.3743	0.3812	050	0.50	0.50	C, 75	0.75	0.15	0.15	90910	90510	0.505	0.506	0.506	0.503	0.499	0.400	361-10	
		FORM	7	æ	ہے	R	٦	f.	F.	F.	P.	R.	R	R.	P.	R	Æ	P.	F.		F.	ہے	
		ORIGINA THICKNE (INCH)	0.625	0.625	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0:	1.0	1.0	1.0	1.25	1.25	1,28	1,28	
	N	I' D' Sbeciwe	ATH-1	ATH-2	ALM2	AL-5	AT-1A	AT-2A	AT-3A	TA-17	TA-18	T.A-23	TA-24	Ā	٧×	¥.	¥	٧×	TA-5	TA-6	₹	¥	

D 0.2% OFFSET
P fty OBTAINED BY STRAIN GAGE

Table 16: Liquid Hydrogen (-423^oF) Tensile Properties of 2219-787 Aluminum Alloy Base Metal, Long Transverse Grain Direction (Continued)

			_						,
	ICE	ВЕРЕВЕЙ	15	15	17	17	17	11	17
	⁽ 9	(b21 × 10. E	١	1	11.3	10.9	11.3	11.7	11.8
		3	-	-	_	_	-	-	1
	NO	% AREA REDUCTI	-	_	-	_	-	-	_
RESULTS	ATION	ЭОАО НТОИЭЛ	2.0	2.0	-	2.0	2.0	2.0	2.0
	ELONGATION	%	11	10	-	12.0	135	15.0	12.0
	E	F _{ty} (KSI)	72.6	72.9	70.2	70.0	8.69	20.0	8.69
		F _{tu} (KSI)	6'001	100.8	8*86	0.66	9.66	2.66	8'86
DATA		DUI QAOJ STAR (IN/IN/II)	0,005	0.005	0.005	0.005	0.005	3000	0.006
TEST DATA		SOAK TIN	۸۸	ΝΑ	٧V	A A	NA	42	N.
CIMEN	CNOICE	W	0.50	0.50	١	ı	-	ı	١
SPECIF	(INCH)	t OR DIA	a.50	0,50	0.505	a505	0.505	0.505	0.505
		FORM	4	권	4	R	F	4	4
		ORIGINA THICKNE (INCH)	2.5	25	1.5	1.5	1,5	1,5	1.5
	N:	SPECIME	AT25-5	AT25-6	۸×	A.	NA NA	NA	٧

Ø 0.2% OF FSET

Table 17: Room Temperature (70º F.-75º F) Tensile Properties of GTA Welded 2219-787
Aluminum Alloy. Square Butt Weld Edge Preparation. 2319 Filler Wire Used.
No Post Weld Heat Treatment.

		_							-									_	_	_	_	_	
ICE	HEFFE	8	8	R	12	12	e	6	92	92	91	16	4 1	1	41	11		41	:	11	13	41	
l ₉	.01 * 1Sa) 1	-		ı	1	1	2	3		1	1	ł	-	1	-	-	-	ł	-	-	-	_	
	3	+	1	-	-	1	ı	22	ı	-	-	-	_	1	-	i	-	ł	-	ı	-	ı	
NO	₩ AREA ITOUG∃R	' '	,	,	-	•	z	R		ŀ	1	-	-	1	ı	1	ı	١	1	i	-	-	
NOITA	36 A 6 HT∂N3J	,	1	,	07	ន	3	2	ន	970	2	01	2.0	ន	07	2.0	970	92	22	3	ຊ	22	¥
ELONG,	3,4	1	1		3.0	2.1	m	m	2	3	3	2	53	3	27	3	930	7	3	23	3	3	NO INFORMATION AVAILABLE ON WELD EDGE PREPARATION
₽	F _{ty} (KSI)	1	-	1	22.97	32.30	27.9	28.5	25.7	28.0	28.6	20.8	¥	¥	NA	Į	¥	74	¥	ş	ş	¥	EDGE PRE
	F te (KSI)	3	50.4	208	18.81	46.80	38.0	38.2	38.2	30.4	3 18 .	38.0	40.9	42.4	41.3	42.0	623	40.6	41.9	42.8	42.1	22	N WELD
1	3TAR	100	\$	ş	ş	ş	0,006	30970	0,000	9000	9000	0,006	0,000	9000	300€	8,005	9000	0,005	90010	9000	8008	0.005	LABLEO
		\$	ş	≨	ş	¥	ş	ş	¥	¥¥.	¥	Ž	ž	¥	¥	MA	3	K	¥	*	ž	¥	ON AVA
SICINS	*	02.0	05.0	3	3	0.50	050	0.50	050	0.50	050	950	150	35	1.50	1.60	1,50	1.50	1.50	150	37	1.50	ORMATI
(INCH)	t OR DIA	Q.10	0,10	0.10	0.125	0,125	Q1232	0,1218	0.0627	0,0630	0,1027	Q.1004	9,50	0.50	0,50	9,50	0.56	0.50	9.50	9.50	950	220	200
	FORM	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	L	R.	P.			P.	it.	R.	£		A
		A .10	3,10	Q , 10	6.125	0.125	Q.125	Q.125	Q.126	Q.125	Q.136	Q.128	950	950	3	3	3	3	3	926	958	3	Q2X OFFSET
N	SPECIME	¥	MA	\$	TWL19 #41	TWU-19	AWR-3	AWRA	TAW-1	TAM-2	TAM-7	TAME	ž	į	ş	2	\$	ş	ş	*	ş	ş	Š
	LINCHI ELONGATION 2	OPPIGINAL SOAK TIME (INCH) SOAK TIME (HOURS) COAK TIME (IN/IN/MIN) COAK TIME (IN/IN/MI	LONGATION THOUGH OF THE CHORD	CORPUSATION LOCATION LOC	A SOAK TIME A 10 A 20 A 1 A 20 A 1 A 20 A 20 A 20 A	ATO SHEET A10 B50 NA B01 B44 A10 A10 A10 B46 NA B01 B46 A10 A10 B46 A10 B4	CORPORATION CORPORATION	Charles Char	Charge C	CHAPTIONS CHAPTIONS CHAPTIONS CHAPTION CHAPTI	Charge C	ALIE SHEET QUEST Q	ALTER SHEET ALTER	ALISE SHEET GLOSS MA	CHARGE C	China Chin	The composition of the composi	Checkers Checkers	Companies Comp	Common C			INCHINGENIESS

Table 17: Room Temperature (700 F-750 F) Tensile Properties of GTA Welded 2219-T87 Aluminum Alloy Square Butt Held Edge Preparation, 2319 Filler Wire Used. No Post Weld Heat Treatment. (Continued)

	1.31	אל נו או ע	=	=	5	=	12	12	:	7.	=	2	ü	2	9	11	17		17	:	17	11	17
	⁽ 9	.01 * 18a) -}	1	1	ı	1	_	l	١	ı	ı	-	-	1	-	-	-	1	i	•	1	_	_
		3	,	i	,		1	1	١	1	ł	1	i		ł	-	-	ł	١	-	-	١	i
	NO	". AREA REDUCTI	1	,		ı	1	,	ł	,	1		1	1	R	ı	1	ı	1	ł	1	1	1
RESUL15	ATION	GAGE LENGTH	2.0	32	20	2.0	2.0	20	ន	97	ន	22	ន	20	3	2.0	2.0	22	2.0	0.2	١	-	ŀ
	ELONGATION	٠,٠	3	3	o _s	93	929	6.0	3	3	3	3	7.4	10.	11	3	3	2	9	3	-	1	-
	£	r v	-	1	1	-	-	1	-	-	ı	ı	20.00	20.57	20.9	_	_	_	-	_	1	_	-
		F. (KSI)	42.6	40.7	02	42.1	42.2	41.1	38.9	30.5	37.2	40.3	36,12	42.46	38.1	6.3	40.1	43.7	45.0	30.7	23	6.19	41.7
DATA		DUIDAOJ TAR M·NIVII)	0,005	9000	2002	0,005	0,006	0,006	0.006	9000	0.006	0,000	ş	¥	¥	0,000	G,0006	0,006	9000	9000	9000	400	800
TEST (SOAK TII	ž	¥	¥	NA	Ş	ž	¥	¥	¥.	ş	ž	¥	¥	¥	ş	¥	M	\$	\$	¥	\$
FIN	SIOIS	¥	1.50	1.50	057	1,50	1.50	1.50	1.50	3	1,50	1.50	0.625	97970	-	2,00	2,00	2.00	200	2.06	2,00	2.00	200
SPECIMEN	(INCH)	O O A	0.50	050	050	03.0	0.50	050	950	050	050	930	850	00270	0.250	1.00	1.00	1,00	1,00	2,00	1,00	1,000	897
		FORM		£	-	٦	e,	•		٠, له	4	aj.	F	1	-	-	•	.	ď	-	4		•
		ORIGINA THICKNI ORIGINA	050	0.50	050	0.50	050	0.50	950	958	950	950	8.9	8.8	0,1	9	1.0	1.0	٦.0	6,1	3	3	2
	N	L.D. SPECIME	¥.	NA NA	NA	¥	Ş	3	ş	ş	ş	4	TWC-18	TWC-18	i ş E	\$	ş	\$	ş	4	ş	ş	\$

O DIN OFFSET

Room Temperature (700 F-.759) Tensile Properties of GTA Welded 2219-T87 Aluminum Alloy, Square Butt Weld Edge Preparation. 2319 Wire Used. No Post Weld Heat Treatment. (Continued) Table 17:

																A	A	A	<u>A</u>	<u>A</u>
		1CE	изизэзя	17	17	17	17	17	11	41	21	11	17	21	11	15	15	15	3	3
		(g.	.01 × 10.	-		_	1	-	-	ı	_	-	1		-		ı	1		9.4
			n	-	1	_	-		-	-	_		1		-	1	1	1	1	0.33
		NO	& AREA ΣΕDUCTI	1	1	1	1	ı	1	1	ı	f	!	1	1	i	ı	ı	61	22
1 1010	RESOLIS	LONGATION	BPAD LENGTH		_	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	20	20	2.0	20
		FLONG	3 €	-	_	8.5	9.0	9,5	8.5	0.8	3.8	0.8	0.6	10,3	9.0	6	80	80	80	80
		<	(=) F _{ty} (KSI)	1	-	1	1	ı	ı	1	1	1	1	I	1	20.3	20.2	19.8	22.1	21.8
			F _{tu} (KSI)	41.7	40.6	40.7	41.8	40.6	41.4	40.6	42.5	43.6	43.3	44.2	430	40.5	40.4	40.3	42.9	429
	DAIA		DUI DAOJ STAR M\UIVNI)	0,006	0.005	3000	0,006	0,006	0,006	0,006	0.006	0,006	0.006	0,006	0.006	NA.	٧	¥	0,006	9000
3 5	IEST		SOAK TIN	٧N	٧×	٧N	ş	4	٧N	٧N	٧N	٧N	٧N	٧N	¥	٧N	¥	4	¥	¥
	SIOUS)	W	2.00	2.00	2,00	2,00	2.00	2,00	2,00	2,00	2,00	2,00	2.00	2.00	020	0970	090	1.00	1.00
SPECIM	DIMENS	(INCH)	t OR DIA	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1,00	1.00	1,00	1.00	1.00	020	050	030	1.006	1.0142
			FORM	P.	4	4	2	4	L	E.	R.	al		R.	E.	T	R.	E.	4	d
			ORIGINA THICKNE (INCH)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
		N	SPECIME I. D.	¥	NA	٧٧	42	٧×	٧٧	٧٧	٧×	NA NA	NA	٧٧	NA	AWT-4	AWT-5	AWT-6	AWR-1	AWR-2

1 0.2% OFFSET 2 NO FILLER WIRE USED

Liquid Nitrogen Temperature (-320°F) Tensile Properties of GTA Welded 2219-T87 Aluminum Alloy. Square Butt Weld Edge Preparation. 2319 Filler Wire Used. No Post Weld Heat Treatment. Table 18:

			A	<u>A</u>	A																			_
	ice	REFEREN	R	R	R	3	e	16	5	16	5	-1	:	:	=	11	=	13	:	:	11	3	=]
	⁽ 9	.01 × 1Sd) .E	1			ē	3	1	1	i			1	1	i	1		1		١		ı	1	
		ą	1	1	ı		8	1	ı	ı	1	ı	1	I		1		١	١		1	1	1	
	NO	A3RA # ITSUG3R		1	1	n	M	1	ı	1		ı	1	1	,	ı	ł	1	1	ı	1		1	
RESULTS	ATION	GAGE LENGTH			1	2	ន	3	2	ន	97	ន	2	3	ន្ទ	3	92	92	2	3	2	3	3	
	ELONGATION	بېږ	ı	1		•	-	•	•	•	•	ន	3	7	3	3	30	3	3	3	3	2	3	
	<u></u>	F ty (KSI)	١		1	à	ă	Ä	, as	21.2	28.0	1	1	1			1	1	1	ı	ı		1	
		F _{tu} (KSI)	233	61.0	0	3	9	- T	3	3	523	3	3	\$1.6	3	87.8	48.7	3	3	3	<u> </u>	3	1.23	
DATA		ONIDAOJ 3TAR M•NIVII)	100	3	100	9000	8008	9000	900	8	18	9000	100	9000	2000	0,006	9000	200	8000	803	8	89	200	
TEST [NT NAOS SAUOH)	ş	1	ş	ş	\$	5	823	3	3	\$	ş	ş	į	ş	ş	ş	ž	ş	1	\$	ž	
AEN	2015	3	050	3	3	3	3	3	3	3	950	3	3	997	3	3	3	3	3	3	3	3	3	
SPECIMEN	(INCH)	- OR AIO	0,10	0, 10	0,10	Q.1228	0,1200	00000	1880	Q.1002	Q.1088	050	osto	970	93	33	973	970	9780	3	3	3	3	
		FORM	SHEET	SHEET	SHEET	SHEET	SHEET	SMEET	SHEET	SHEET	SHEET	-	E.	L	-	ſ	. 1.	1	T	J			-	
		ORIGINA THICKNI (INCH)	0.0	01.0	0.10	Q.125	Q.126	Q.125	0.126	Q.125	Q.125	030	950	030	950	0.50	970	920	950	3	3	3	3	
	N :	SPE CIME	1	ş	ž	AWM-3	ANN.4	TAMS	TAMA	TAME	TAW-10	ş	NA	¥.	¥	¥	MA	ž	¥	ş	ş	ş	ž	

2> NO INFORMATION AVAILABLE ON WELD EDGE PREPARATION

Liquid Nitrogen Temperature (-320°F) Tensile Properties of GTA Welded 2219-T87 Aluminum Alloy, Square Butt Weld Edge Proparation. 2319 Filler Wire Used. No Post Weld Heat Traetment. (Continued) Table 18:

	40	иненини	ı.	=	1.	12	1.	17	17	17	•	7.	1.	11	13	1.1	17	13	12	11	17	11	7.1
	(_y	.01 × 18a) J		-	1		-	ı	1	-	1	<u>'</u>	١	,	1	+	-	1	ı	•	-	•	1
		a	,	 	ļ	ı	-			,	,	,	1	,	,	-	1	-	1	1	-	1	
S	NO	" AREA REDUCTI	-	,		<u> </u>	-	,	1		u		,	,		ļ	1	ı	١		,	,	-
RESULT:	LONGATION	30A0 HT0N31	97	ន	07	97	97	20	20	2	3	20	2	ន	07	20	2	ង	2	2	ន	2,0	2
	ELUNG	,ş ^t	3	S.	ş	3	2,5	3	3	3	16	9	3	3	3	3	33	521	10.5	3	3	57	σz
	4	Z * S	1	1		-	·	1	1	ł	ZA.	1	1	1	1	-	_	-	-	1	1	-	-
		F. (KS)	52.5	8.18	9.6	Æ	3	ā	SOS	3	86.5	33	32	3	3	739	6.43	o'49	FE.7	3	3	('M	l M
DATA		ONDGAOJ 3TAR M·NIVII)	0,005	0,005	0,006	9000	0,006	9000	0000	0,006	ş	0,000	9000	0000	200	0,005	0.005	9000	0,006	0,006	9000	90078	9000
TEST		SOAK TIN	¥	¥	٧×	¥	ş	¥	¥	\$	ş	ş	\$	\$	ş	٧N	ş	1	¥	YN.	¥74	YN	W
SPECIMEN		3	1.50	1,50	1.50	1,50	1.50	1.50	1,50	1,50	-	2,00	200	2,00	200	2.00	2.00	2.00	2.00	2:00	2.00	2,00	2.00
SPECIMEN	(INCH)	OP A	020	0.50	0.50	950	050	920	3	950	0.251	1,00	1,00	1,00	1,00	1.00	1,00	1,00	1,00	00 7	0071	1,000	1,00
		FORM	-	٦		r.	F	7	٠		L	E.		ı,	£		.	4	1		ſ	ı	F
		(INCH) THICKNI OBICIVI	0.5	9.5	3	જ	3	3	3	3	0,1	2	0,1	1.0	1.0	d.	2	3	LO	20	3	3	9
	N	I' D'	V.	ž	4	Ş	\$	ş	ş	ş	ITM-2	\$	ş	4	ş	ž	۲	ş	ş	¥	¥	\$	ž

⊘ azsoreset

Taule 18: Liquid Nitrogen Temperature (-320ºF) Tensile Properties of 3TA Welded 2219-787
Aluminum Alloy. Square Butt Weld Edge Preparation. 2319 Filler Wire Used.
No Post Weld Heat Treatment. (Continued)

											A	A	A	A	A
		ICE	EV	434	38	41	41	41	41	41	15	15	15	3	က
		·g	١٥.	х <u>1</u> ! Э	Sd)	-	-						-	10.7	11.4
				3		-	_	1	-	-	1	1	-	١	0.29
	S	NO		BB/		-	-	_		-	-	-	-	13	15
	RESULTS	ELONGATION		de PSE		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
		ELONG		%		7.0	7.0	7.5	7.5	7.5	6	6	6	7	7
"		<u> </u>	ij	T,	(KSI)	İ	-			1	24.5	26.2	24.7	25.9	27.7
Continuea				r _U	(KSI)	53.9	52.7	26.0	55.4	53.4	6'99	56.3	56.2	54.7	56.2
atment. (TEST DATA		∃.	GΑ ΓΑЯ)	0,005	0,006	0.005	0.006	0,005	۸A	٧¥	٧	0.005	v.006
Post Weid Heat Treatment. (Continued)	TEST			ION VK		٩N	AN A	٧×	٩N	۷V	ΑN	٧٧	V	NA NA	₹ Ž
	SPECIMEN			3		2,00	2,00	2,00	2,00	2,00	020	0.50	0'20	1.00	1.00
NO	SPECIM	(INCH)		08 0	DIA	1.00	1,00	1,00	1,00	1.00	0,50	a 50	Q.50	1.0175	1,0230
				FORM		4	F.	F.	R.	ڀ	Æ	F	7	R	ہ
			3N	ICH IICk IICk	ΗT	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
		N	3W	ECI	dS Sb	ΝΑ	٧N	٧N	٧N	٧V	AWT-7	AWT-8	AWT-9	AWN-1	Z-NMY

1 0.2% OFFSET

NO FILLER WIRE USED

Table 19: Liquid Hydrogen Temperature (-4230F) Tensile Properties of GTA Welded 2219-T87 Aluminum Alluy. Square Butt Weld Edge Preparation. 2319 Filler Wire Used. No Post Weld Heat Treatment.

			A	A	A	A	A	A	A	8													
	401	N 1 R 1 1 1 R	8	8	8	8	8	8	3	3	17	17	17	11	17	17	41	41	17	17	17	11	17
	(₉	,01 * 18a) E	1	1	1	1	-	-	10.9	10.6	1	_	+	_	_	1	-	-		-	-	-	-
		د	-	_	-		-	-	-	0.31	1	_	-	-	1	1	1	1	_	-	1	-	-
	ŊΟ	ΑΒΕΛ REDUCTI	١	1	١	ł	+	1	ı	1	ı	١	ì	1	1	١	ı	ı	-	-	ı	-	1
RESULTS	ATION	CAGE LENGTH	1	_	1	1	_	_	1	1	2.0	2.0	2.0	20	2.0	20	2.0	92	2.0	20	2.0	2.0	20
	ELONGATION	3FF	1	-	-	1	_	1	1	1	3.0	3.5	2.5	35	9	જ	\$	\$	40	3	3.0	\$	3
	£	7 7 <u>5</u>	1	1	1	١		1	34.2	787	-	1	1	-	1	-	ı	1	-	l	1	-	1.
		t _u 'KS!)	72.2	86.9	20	, 96 .5	68.7	3	68.7	87.8	7	9729	1,385	67.8	5186	9795	87.8	66.7	974	6'90	2'98	773	478
DATA	!	DUIDAOJ 3TAR (IN/IN/INI)	0.01	400	0,01	100	0,01	0.01	9000	Q.006	9000	9000	9000	9000	9000	900'0	9000	0,005	9000	0,006	9000	9000	0,006
TEST DAT		SOAK TIN	¥	Ş	٩	ş	Ž	٧	Ž	₹	ž	ş	¥	٧	¥	ş	ş	ž	¥	Ş	ş	ž	ş
SPECIMEN	SIONS	≩	050	050	osto	0.50	050	050	050	050	057	1,50	1,50	1,50	1.50	1,50	1.50	1.50	1.50	1,50	1,50	1.50	1,50
SPECIMEN	(INCH)	OR DIA	0,10	0,10	0,10	0,10	0,10	0,10	0,1298	0,1200	0.50	050	050	050	0.50	9.50	050	050	0.50	0.50	030	950	33
		FORM	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	-	,	2	-	e e		1	پ	-	-	4		7
		ORIGINA THICKNE (INCH)	Q,10	0,10	0,10	Q.10	0,10	0.10	Q.125	0,125	050	050	050	0.50	0.50	050	050	050	020	030	050	050	050
	N	I, D,	¥	ž	¥.	ş	₹2	ž	AWH-3	AWH-4	N.	¥	¥	¥	Ž	¥2	¥	\$	¥	MA	¥	\$	¥

F_{ty} DETERMINED BY STRAIN GAGE ON WELD C C.Z% OFFSET

F_{Ty} DETERMIN

NO INFORMATION AVAILABLE ON WELD EDGE PREPARATION

Liquid Hydrogen Temperature (-423ºF) Tensile Properties of GTA Welded 2219-787 Aluminum Alloy. Square Butt Weld Edge Preparation. 2319 Filler Wire Used. No Post Weld Heat Treatment. (Continued) Table 19:

	ICE	HEERE	5	=	:	2	=	2	17	=	=	:	:	=	11	:	17	17	17	ï	17	17	2
	⁽ 9	.01 × 18d) .1	,	,	ı	. 1		Į.	1	1	1	1	ı	,	١	-	1	ı	1	ı	1	-	1
		3	-		;	1	,		ı	,		,	,	,	ı		,	ı	-	1	1	į	•
	NO	". AREA HDUGTA			1	1	,	ı	i	,	1	,	1	-	ŀ	1	ı	i	:	1	1	1	1
RESULTS	TION	3545 HT5M31	20	2.0	2	2.0	20	20	2.0	20	2	62	20	20	20	2	97	20	2	ឡ	20	07	97
	ELONGATION		2	45	ş	9	35	ş	5.0	3	3	0.8	038	2	7.5	9	579	3	9	3	3	3	3
	4	7 5 <u>\$</u>	1		,	t	,	1	1	1	1	1	1	1	1	ı	1	1	,	1	ı	ı	-
		ار (KSI)	59.9	62.4	80.5	58.2	56. 9	58.9	64.5	77	28.3	130	86.2	67.0	28	67.2	873	3	62.6	623	67.6	1,38	0'99
DATA	1	DUIDAOJ 3TAR (M·UNNI)	0,006	0000	0,006	9000	a.006	9000	90000	0,006	0,005	9000	0.006	9000	0,006	0.006	0.006	0,006	0.006	9000	9000	900'0	0.006
TEST C		(HONES	¥	Ą.	ş	\$	≨	ž	¥N	ş	ž	ş	ş	ž	\$	ş	Ş	ş	4	ş	\$	ž	NA
EN	SIONS	š	1.50	1.50	1,50	1,50	1,50	1.50	2,00	2.00	2,00	2,00	2,00	2,00	200	200	200	200	2,00	200	2,00	2,00	200
SPECIMEN	(INCH)	† OR DIA	0.50	Q.50	05.0	0.50	0.50	0.50	1,00	1.00	1,00	1,00	1.00	1,00	1,00	1,00	1,00	1.00	1,00	1,00	1,00	1.00	1.00
	- -	FORM	7	4	1	,		-	L	L	£	E.	,	F	F	,	.	٦	F	7	7	1	T.
		(INCH) THICKNI OBICINA	0.50	0.50	050	050	0.50	050	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2	1.0	1.0	20	0. 1	1.0	1.0
	N	P. D.	¥.	٧.	٧V	NA	¥.	\$	Ş	¥	¥	¥	N.	¥	¥	¥.	M	NA	¥	¥	¥	ž	ž

D 0.2% OFFSET

Liquid Hydrogen Temperature (~323°F) Tensile Properties of GTA Welded 2219–T87 Aluminum Alloy. Square Butt Weld Edge Preparation. 2319 Filler Wire Used. No Post Weld Heat Treatment. (Continued) Table 19:

				A:A	<u> </u>	<u>vy</u>	77	
1CE	REFEREN	17	17	15	15	15	ε	3
⁽ 9	(b21 × 10.	1	-	-	-	-	10.4	9.3
	ת	1	-	-	1	-	١	96.0
NO	% AREA ITOUGER	_	-	-	1	_	6	6
ATION	ЭБАБ НТӘИЭЛ	2.0	2.0	2.0	2.0	2.0		-
ELONG	÷ ⁸	3,5	5,5	11	11	01	1	ı
	F _{ty} (KSI)	1	1	31.5	27.6	27.1	33.3	30.9
	F _{tu} (KSI)	59.8	58.8	67.0	68.6	67.2	979	62.6
	BATE	രായ	0,306	Ş	Š	ş	0,005	g006
		ş	ž	Ą.	¥	ž	٩	≨
SION	≯	200	230	0,50	0.50	0,50	1.00	1.00
ENCH]	t OR DIA	1.00	1.00	05.6	020	0.50	1.0090	1.0186
	FORM	١	=	یے	یے	نه	a	اله ا
		0.1	1.0	1,0	1.0	1.0	1.0	1.0
N	SPECIME	¥	4 Z	AWT-1	AWT-2	AWT-3	AWH-1	AWH-2
	L SS (!NCH) E S ELONGATION S 6)	ORIGINAL FORM T PORM TO THINE ORIGINAL SOCIETY OF THE SOCIETY OF T	D. D. D. D. D. D. D. D.	Dimensions	1.00 1.00	1.00 1.00	Commensions Commensions	Commercial Com

D 0.2% OFFSET

F_{ty} DETERMINED BY STRAIN GAGE ON WELD

NO FILLER WIRE USED

Table 20: Room Temperature (70° F–75° F) Tensile Properties of GTA Welded 2219-T87 Aluminum Alloy Square Butt Weld Edge Preparation. 2319 Filler Wire Used. Aged After Welding. \triangleright

		1.)t	итити	12	12	12	12
		6)	.01 × 18a) E	-	-	-	-
			د	ı	l	,	1
		NO	∾, AREA ITOUG∃R	_	I	i	1
	RESULTS	ATION	30A0 HTON3J	2.0	2.0	20	2.0
		ELONGATION	o*	1.3	2.1	ഔ	1.5
		Æ	7 ⁷ 7	43.48	43.51	31.78	31.91
			F _{tc} (KSI)	51.57	51.70	38,689	44.74
	DATA		DUIDAOJ TAR (MAINAII)	∀ 2	¥ Z	ş	ş
,	TEST DATA		(HONBS	٧×	Ą	ş	Ž
	SPECIMEN	SIONS	\$	00500	0.500	9625	0.625
•	SPECIMEN	CINCH	t OR DIA	Q.125	Q.125	00200	0.200
			FORM	SHEET	SHEET	F	٦
			ORIGINA THICKNE (INCH)	0.125	0.125	a.750	0,750
	_	N-	I' D' SBECIME	T-WU-19	TWU-19	TWU-19	TWU-19

D 0.2% OF FSET

NATURALLY AGED 4 DAYS, THEN ARTIFICALLY AGED 24 HOURS AT 325°F ± 10°F

Table 21: Room Temperature (70 o F -75^{o} F) Tensile Properties of GTA Welded 2219–T87 Aluminum Alloy Square Butt Weld Edge Proparation. 2319 Filler Wire Used. Solution Treated and Artifically Aged After Welding. \square

		ICE	 HFFFRF <i>N</i>	2	2	12	23
		⁽ 9	.01 × 1Sa)	-	ŀ	ı	-
			3	'	1	1	1
	٠,	NO	# AREA TOUGBH	_	1	ı	-
	RESULTS	ELONGATION	GAGE HTƏNƏJ	07	ន	2	ន
		ELONG	æ	12.3	12.0	201	3
		Æ	χ. ζ. <u>ξ</u>	52.88	52.41	44	43.24
			F _{tu} (KSI)	98.98	98,86	61.50	62,10
٠	TEST DATA		DNIDAOJ 3TAR M:NIVII)	ş	ş	ş	¥
	TEST		CHOURS	ş	ş	ş	ş
	SPECIMEN		*	853	00500	0.625	0.625
	SPECIMEN	(INCH)	or OIA	Q.128	0,126	0,200	07200
			FORM	SHEET	SHEET	-	1
			ORIGINA THICKNI (INCH)	0.125	0.125	Q.126	0.750
		N:	I' D' SBECIME	TWL19	TWL19	TWL-19	TWL18

 α 125 sheet was solution treated in Neutral Salt for 56 minutes at 995 o F \pm 10 o F, a750 f q was solution treated in Neutral Salt for 70 minutes at 995 $^{
m o}$ F \pm 10 $^{
m o}$ F, MATURALLY AGED 4 DAYS, THEN ARTIFICALLY AGED 24 HOURS AT 325°F \pm 10°F NATURALLY AGED 4 DAYS, THEN ARTIFICALLY AGED 36 HOURS AT 375°F \pm 10°F 0.2% OFFSET AA

Room Temperature (70° F–75° F) Tensile Properties of GMA Welded 2219-T87 Aluminum Alloy. Doubbe 70° "V" Weld Edge Properation. 2319 Filler Wire Used. No Post Weld Heat Treatment. Table 22:

Г			<u> </u>	ءِ ا	2	=	\	i _		Ι_	T_		=	=	=			T .	Γ.	<u> </u>	_	_	Ţ_	1
_	ال		F	<u> </u>	-	-	=	17	=	-	=	-	_	<u> </u>	<u> </u>	=	1,1	=	=	:	-	=	=	
	(9)	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	,	1	'	,	1				,		1	1	,	'	1		,			,	1	
		a	,		, ! !	,	1	'	ı	,	,	1		1	,	,	1		,	'	,	:	-	
	NO	* ARENCTI	ł		,	,	ı	,	,	,	1		1	1	1	,	,	1	,	,	,	,	,	
RESULTS	NOLE	30A8 HT8N3J	2.0	20	2,0	20	0,5	22	2	2	ន	2	ន	2	2.0	2	ន	2	ន	2	2	ន	ន	
	ELUNGATION	o ⁵	0.8	7.0	0.0	7.0	0,0	50	33	93	5.0	ş	3.5	5.0	9	3	ន	7.5	3	0,7	3.0	8.0	3	
	6	7 - 7 (KS)	1	1		-	1	, ,	1	1	1	ļ	1	1	1	ŀ	ŀ	1		ı	ŧ	1		
		F L: (KSI,	42.2	41,5	42.0	42.1	41.6	9	38.9	ğ	36.3	38.0	43.7	41.8	1.2	44.1	43.3	23	121	828	40	3	9	
DATA		DVIGAO J 37 A A IM: VINNI)	9000	C.005	0,006	Q.005	0,005	0.006	0,005	9000	9000	0,006	9000	0,006	9000	9000	9000	800	0.000	0,000	0,006	9000	9000	
TEST D	1	CHOURS	٧N	ş	₹2	¥	₹	Ş	ş	Ž	ž	ž	¥.	¥¥	ş	¥	2	5	ş	ş	ş	2	ş	
EN	SNOWS	*	1.50	1.50	3.	1.50	1.50	1.50	05.1	1.50	35,	1.50	1.50	1.50	050	1.60	1.50	200	2.00	2.00	2.00	200	897	
SPECIMEN	CINCH	OR عال	0.50	0.50	020	0.50	050	050	0.50	35	0.50	0.50	020	050	050	05.0	050	1,00	1,00	1.00	1.00	700	3	
		FORW	4	.	-	L	-	-	E.		7	-	-	-	-		-	-	-	7	-	-		
-		ORIGINA THICKNE ORIGINA	0.5	0.5	979	979	9.5	3.0	90	9.5	30	0.5	9.5	9.5	9.5	978	9.5	1.0	1.0	0,1	1.0	0,1	3	0 24 OFFEET
	N	l' D' ZEECHWE	¥.	٧V	NA	¥	Ž,	\$	Ş	V.	N.	ş	\$	NA NA	¥.	¥	¥	NA	¥	NA	¥	MA	\$	200

Table 22: Room Temperature (70º F-75º F) Tensile Properties of GMA Welded 2219-T87 Aluminum Alloy.

1	_			ı—														1						
		ICE	REFEREN	=	11	:	=	13	1,	11	11	11	11	11	17	"	13	17	13	"	13	"	4.	#
(panu		(₉	(b21 × 10.		ł	-	1		-	-	-	-	+	-	_	ı	١	i	-	1	1	i	1	,
t. (Conti			3		ł	_	-	ŀ	ł	-	-	-	-	1	-	1	-	-	_	-	-	_	_	•
reatmen		NO	# AREA TOUGIE		1	. 1	i	ı	1	1	ı	ı		1	ł		-	ı	-	1	_	_	-	1
ld Heat	RESULTS	ATION	GAGE HTON31	ន	ន	3	3	ន	3	22	92	ង	ន	92	2	ន	92	972	22	0.2	92	97	978	3
No Post Weld Heat Treatment. (Continued)		ELONGATION	*	3	þ	3	ş	3	3	3	3	3	3	3	3	3	3,5	072	220	0,1	3	93	3	3
		<	¶ ^r (§	-	ı	1	,	1	-	ı	_	_	_	_	_	1	_	_	÷	_	_	-	_	-
2319 Filler Wire Used.			F _{tu} (KSI)	\$	41.7	41.7	23	6.7	1.0	66.7	6.7	7	4.2	46.0	6.4	3	66.3	2.5	*	6.2	0.30	3	44.7	9
	DATA		ONIGAOJ 3TAR M\NI\NI)	800	8000	9000	8000	9000	0.005	9000	9000	9000	0,006	0,005	90079	9000	9000	0,006	0,006	9000	9000	8008	9000	9000
paration.	TEST [. (SOAK TIN	\$	ş	ş	į	į	ş	ş	ş	\$	ş	ş	ş	ş	ş	ş	ž	¥	NA NA	\$	MA	1
"V" Weld Edge Preparation.	FEN	SICINO	*	8	200	200	200	200	200	2.00	2.00	200	05.1	05.1	097	3,1	LE 0	350	3	1,50	1,50	957	087	85
V" Weld	SPECIMEN	(INCH)	OR OIA	8	95	1.00	567	1,00	3	1,00	1.00	307	011	1.50	1.50	1,50	0971	051	0973	0971	9571	937	87	3
Double 70°			FORM	ر ا	•	J	4	ړ	_	4	-	-	-		-	-	L	-		L	L		4	
DO			ORIGINA THICKNE (INCH)	3	3	9	3	3	3	3	2	2	2	2	2	2	3	3	3	2	3	2	2	2
		N	I' D' Sbf CIWF	ş	ş	ş	ş	ş	ş	¥	¥	\$	¥	ş	\$	\$	\$	ş	ş	\$	ş	\$	1	¥

D azsoneser

Liquid Nitrogen Temperature (-320°F) Tensile Properties of GMA Welded 2219-T87 Aluminum Alloy. Double 70° "V" Weld Edge Preparation. 2319 Filler Wire Used. No Post Weld Heat Treatment. Table 23:

	HOE	HELEBEN	=	=	12	=	17	:	=	7	7	=	11	=	:	11	17	13	2	17	17	17	
	•	(b21 × 10.	1	1	1	1	,	1	1	1	,			1	l	1	-	-	-	-	_	1	
		4	1	1	1	ı	1	1	,	ı	,	ı	-	1	ł	1	-	ı	ı	-	-	1	
RESULTS	NO	₩ AREA		ı	1	1	1	1	ł	1	,	1	1	-	1	1	ı	ł	ı	١	_	-	
RESULTS	ATION	GAGE HTONEL	ង	2	2.0	ន	970	2	22	2	ร	ន	2	97	2	ន	92	2	22	22	0.2	97	
1	ELONGATION	æ	7.5	7.0	5.0	6. 0	10.0	30	3	0 °	ระ	57	3	9	3	3	0'5	3	3	9	3	2	
	₽	, r KSI	-	-	-	1	1	-	1	ı	1	1	1	1	-	-	-	1	1	1	-	-	
4		ا الا عاد (KSI)	6798	1.73	53.4	93	3	43.1	-4	3	47.3	3	9.08	3.06	3	60.7	908	3	23	833	179	23	
1	IN	DUI (I AO J STAR (I M'N I N N I)	0,006	0,005	9000	9000	g 0006	0000	9000	0000	9000	9000	9000	Q.006	9000	9000	0,006	9000	9000	6,005	9000	9000	
TEST DAT	ι	CHOOF	ž	\$	ş	\$	ş	\$	ş	ş	ş	ž	ş	2	ş	ş	ş	ş	ş	ş	1	ş	
SPECIMEN	S C S	\$	93	3	2	3	3	3	3	3	3	3	3	3	3	3	3	200	803	82	2.00	2,00	
1	INCH	OR DIA	9	050	3	3	9	3	9	3	950	3	oso	3	3	OS O	950	200	3	28	1,00	1,00	
		FORW	د	و.	a	ن ا	-	۔	٠	4	-4	۵	4	۵	٠	d	4	٠	4	٥	ď	٠	
		OBIGINA OBIGINA	3	3	3	58	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	
	N	L.D. SPECIME	\$	ž	4	Ž	ş	1	ş	ş	¥	ş	ž	\$	ş	ş	ž	\$	ş	\$	MA	ş	

D azsoreset

Liquid Nitrogen Temperature (-320 o F) Tensile Properties of GMA Welded 2219-T87 Aluminum Alloy. Double 70 o "V" Weld Edge Preparation. 2319 Filler Wire Used. No Post Weld Heat Treatment. (Continued) Table 23:

	401	RELEREN	17	17	17	17	17	17	:	=	ä	=	17	17	=	17	1,	17	13	=	13	2	
	(9	.01 × 10.	-	1	,	1	1	1	1	-	-	ı	ł	-	-	-	i	ŀ	+	-	1	-	
		3	'	!	ı	_	i	1		,	1	,	ł	-	,	j	١	1	1	ı	-	+	
	NO	% AREA ITOUGJA	'	-	•	,	-	-	1	1	,	,	1.	,	,	-		ł	ı	١	'	ł	
RESULTS	ATION	GAGE HTON3J	2.0	2.0	2.0	2.0	97	2.0	ន	ន	ន	2.0	2.0	2.0	ន	2.0	22	22	ន	ន្ទ	2	2	
	ELONGATION	30	5.5	0.9	3	5.5	2	3.5	0.8	3	3	23	3.5	5.5	\$5	Ş	3	3	3	3	3	3	
	4	Ž [™] Ş	-	-	1	1	1		1	ı	1	,	ï	1		-	1	i	-	-	-	1	
		f. (KSI)	57.1	97.5	62.8	56. 6	62.6	62.5	3	586.9	38	5,95	87.8	27.7	56.7	56.0	58.7	97.5	57.7	ā	3	53.5	
DATA	:	ONIGAOJ STAR IM·NIVII)	0.006	0.005	000g	0.005	9000	0.006	0,006	9000	9000	0,005	0,006	0,006	0,005	0,006	0,006	90070	9000	0,005	900	0,006	
TEST C	1	(HOURS	₹ 2	4%	4 2	ž	4	ž	ž	ş	Ž	ž	ž	₹	ž	ž	¥	ş	\$	ş	ş	ž	
EN	SIONS	\$	2,00	2.00	2.00	200	2.00	2.00	3.0	1,50	1,50	1,50	1.50	1.50	3	150	03.7	1,50	05,1	1,50	35	35	
SPECIMEN	CINCH	- 08 DIA	1.00	1.00	1.00	1,00	1.00	1,00	03.1	1,60	357	ož.	1.50	1,50	3	150	3	35.	35	3	35	250	
		FORM	F	-	یے	F	پ	F	ہ	ي	2	یے	L.	IL.		-	4	ن	ی		4	پ	
		OBIGINA OBIGINA	1.0	10	1.0	1.0	1.0	70	5	1.5	1.5	3	1.5	1.5	\$1	1.5	3	2	3	,	3	3	FSET
	N	T D' SBE CIME	42	٧×	₹	Ą	42	¥.	4	\$	₹	ş	\$	NA	ş	¥	\$	ž	ş	ş	ş	\$	D 0.2% OFFSET

Table 24: Liquid Hydrogen Temperature (-423ºF) Tensile Properties of GMA Welded 2219-137 Aluminum Alloy. Double 70º "V" Weld Edge Preparation. 2319 Filler Wire Used. No Post Weld Heat Treatment

				т	_	Υ		γ	γ	, —	т	r –	_	r—		1		,		_			_
	ICE	REFEREN	=	=	=	2	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	E	=
	(₉	(621 × 10.		1	١		1	1	1		ı		١	1			1	١	1	1	١	1	١
		3	-	1	١	,	1	-		ı	ŀ		1	1	1	-	١		1		ı	-	ŧ
	NO	% AREA ITOUG∄H	1	-		-	1		1	'	-	1	ı	<u>'</u>	1	١	1	•	'	!	1	,	1
RESULTS	ATION	GAGE HTƏNՅJ	2.0	97	2,0	ମ	2.0	2	2,0	2	07	ន	22	2	92	92	2	ន	20	2	2	ន	ន
	ELONGATION	بغو	33	S	5.0	0.3	3.5	2.5	95	2	2.5	30	ş	ន	\$	3	2	ş	ä	ş	3	3	3
	<	, t B	-	-	I	1	1	1	-	ı	ı	1	ł	ı	ı	1	-	ı	ı	ı	1	ı	,
		F ₁ c (KSI)	68.6	61.3	90%	61.2	63.6	48.6	52.4	50.8	51.6	48.8	71.2	68.9	31.7	72.6	70.1	61.5	62.4	54.6	e d	3	3
CATA		DIOADIU STAR M'NIVII)	90070	0,006	0,006	9000	0,006	0,005	9000	9000	9000	9000	0,00 6	9000	0.006	0.006	0.005	0,006	0.006	0,006	9000	0.006	0,006
TEST [SOAK TII	¥	ş	¥	YN	V	٧V	¥	¥	¥	VN	VN	٧N	¥	¥	YN	YN	٧N	1	ş	¥	ş
SPECIMEN		\$	1.50	1,50	1.50	1.50	1,50	1,50	1,50	1.50	1,50	1.50	1.50	1,50	1.50	1.50	05.1	2.00	2,00	2.00	207	2.00	2.00
SPECIMEN	INCH	OR DIA	O'EO	05.0	050	050	0.50	050	020	050	050	050	050	050	0970	090	970	1.00	0071	007	00"1	00°1	1,00
		FORM	۲	ہے	.	J.	4	٦	4	, L	~	4	4	٦	4	,	4	F	, L	F	R	A.	2
		ORIGINA THICKNI (INCH)	978	978	0.5	30	978	Q.5	20	30	978	9.5	0.5	0.5	9.5	26	0.5	1.0	1.0	1.0	1.0	1.0	r _o
	N:	SPECIME I, D.	ş	٧×	ş	¥	MA	¥	ž	×	۸A	٧	₹ 2	٧V	N.A	٧×	٧×	¥	NA NA	NA.	NA	PLA	ş

D a2x OFFSET

Table 24: Liquid Hydrogen Temperature (-423º F) Tensile Properties of GMA Welded 2219-T87 Aluminum Alloy. Double 70º "V" Weld Edge Preparation. 2319 Filler Wire Used. No Post Weld Heat Treatment (Continued)

	4CE	RETEREN	17	7	1.1	17	11	ŗ	ï	ï	=	=	17	:	17	13	13	17	13	13	11	17	ä
	l ₉	.01 × 1Sd) 	١	ı	1	1	ı	ı	ı	-	i	ł	ı	-	1	-	ı	_	-	-	_	-	_
		3	t	1	-	-	1	1	_	-	ı	-	-	ı	-	-	ı	-	1	-	_	ł	-
	NO	% AREA ITOUGIA	1	ı	i	-	1	1	-	1	1	-	-	-	-	-	-		-	-	-	-	-
RESULTS	LONGATION	GAGE LENGTH	2.0	20	2.0	2.0	23	2.0	970	3	20	20	oz	20	07	07	oz	σz	20	2.0	972	072	2
	E LONG	بهي	\$	5.0	ş	3	97	3	9	3	0.48	\$	07	3	9	7	3	3	3	3	97	7	3
	£	7 v, (KS)	-	1	1	١	ı	-	١	ı	-	1	ı	1	i	-	1	1	1	 -	_	ł	_
		F _t .	66.4	63.6	67.6	638	87.5	67.0	0.4	61.7	2	626	60.7	7 95	1.48	612	823	3	3	298	62.6	1700	(23)
DATA		DUIDAOL STAR M-UIVII)	0.005	9000	0,005	0.00%	900	0.006	9000	0,006	9000	0,006	9000	0,006	90070	9000	9000	9000	9000	\$ 20	200	9000	9000
TEST DATA		SOAK TIN	ş	≨	ž	ž	≨	ş	ş	≨	\$	ş	¥	2	ş	¥	4	4	ş	\$	ž	¥	¥
IEN CONC	SIONS	⋠	2,00	200	200	2.00	2,00	2.00	200	3	34	3	3	3	33	3	0971	3	3	3	3	3	3
SPECIMEN	(INCH)	OR DIA	1.00	1,00	8	8	1,00	3	1.00	1,50	1.50	1.50	037	1.50	05.1	04.1	057	337	3	3	3	97	3
		FORM	•	4	ي	J	ď	ړ	ړ	4	۵	J	١	e!	٤	٠	4	4			d	4	•
		(INCH) THICKNE OBICINA	0,1	9	0,1	70	dī dī	3	6.	2	3	3.	2	3	2	3	3	3	3	3	3	2	3
	N	l' iu' Sbeciwe	≨	4	ş	ž	\$	ş	\$	\$	\$	\$	ş	ş	1	\$	\$	ž	2	ž	1	2	Į

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 Table 25: Room Temperature (709 – 75° F) Surface Flawed Fracture Tests of 2219–187 Aluminum Alloy. RT

 Propagation Direction

	REFERENCE	3	3	3	6	3	3
	K2IΛ <u>IN΄</u> K ^{IE}	48.23	45.60	48.32	45.05	43.33	46.70
RESULTS	κει <u>λιи:</u> κ ^Ι (เษмוи)	29.86	41.10	41.22	37.92	38.36	40.49
PES	טאפד ^{/ט} צופּנס	0.43	0.83	0.81	0.74	0.71	0.75
	(KZI) ดูติBO22	21.7	42.3	39.8	35.8	37.2	39.0
TEST. ING	(KZI/WIN) BATE LOADING	NA	٧٧	۸N	Ą Ą	A A	A N
TEST PREP.	PRIOR ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR
TEST	(HOURS)	ΑN	NA	٧V	NA	NA	AN
NG	(* 1,000) CYCLES	NA	NA	ΝĀ	¥ Z	NA	A N
PRECRACKING	Œ	NA	N.A.	NA	۸A	N A	Š
PRE	ە (KSi)	≤16	≥16	≤16	≤16	≥ 16	≥16
INCH)	æ	5.380	1.190	1.370	1.440	1.343	1.353
DIMENSIONS (INCH)	3	0.530	0.432	0.485	0.527	0.530	0.538
DIMEN	اسه	20.0	10.0	10.0	10.0	11.0	11.0
SPECIMEN [≩	22.0	6.75	6.75	6.75	12.0	12.0
SS EC		0.638	0.644	0.629	0.641	0.672	0.644
	РОЯМ	ہے	ہے	ہے	4	ď	2
СН)	THICKNESS (IN	0.625	0.625	0.625	0.625	0.625	0.625
	I'D' SECIMEN	AB54R-1	AB45R-1	AB54R-1	AB54R-1	A857R-1	A857R-2 0.625

Table 26: Room Temperature (709–750 F) Surface Flawed Fracture Tests of 2219-787 Aluminum Alloy. WT Propagation Direction

		_	_	•	,	_			·					_				_			
	REFERENCE	؞ٙ	z	п	n	n	8	я	22	a	a	a	n	z	a	a	a	a	я	n	z
	KZI <u>(IM.</u> K ^{IE}	1 .6	43.4	4 .6	43.0	42.5	1.4	1	4.5	43.6	43.5	2.2	43.3	43.4	43.1	43.7	43.2	4.6	45.3	4. 3	43.8
RESULTS	К21 <u>ДІИ</u> К ¹ (ІВМІИ)	£ 0 4	8	40.5	7.86	38.3	41.2	40.3	40.5	6.98	6.08	- Q	0. 86	8.5	38.8	38.3	38.2	9.04	6.04	40.2	39.2
RES	"ONET !OVEELD	0.88	88.0	0.87	0.87	0.82	0.89	0.87	0.87	0.87	0.87	98.0	0.83	0.85	0.82	0.83	0,94	78.0	0.87	98.0	0.83
	(KSI) oCBOSS	47.92	45.8	8.	8.4	41.3	46.4	6.1	4.5	1.4	1.2	43.4	42.1	43.5	41.7	42.4	43.1	44.9	4.2	43.9	41.8
TEST	(KZI/WIN) BATE LOADING	٧	ď Z	ď	¥ Z	4 2	42	۷ 2	₹ Z	۷ ۷	Ą Z	4 2	₹ V	4 2	٧N	4	ď Z	₹	ď Z	₹ 2	4
PREP	ENAIBONMENT BBIOB	AIR	Δ	\triangle	\triangle	Δ	\triangle	GH,	GH ₂	GH ₂	GH,	GH ₂	GH ₂	GH2	LH2	LH ₂	5	602	602	102	20ء
TEST	SOAK TIME	۸×	A A	A S	A A	₹	¥ Z	₹ Z	A A	¥ Z	Ą	∀	A N	Ą	A N	A N	¥	ď	ď Z	∢ 2	42
S S	CYCLES	₹ Z	A S	۸×	A X	ď Z	ď Z	₹	ď Z	4	¥ Z	¥ Z	₹	٧¥	٧	N.A	٧	∢ 2	4 2	4	۸
PRECRACKING	œ	1.0	4 2	NA	42	A'A	ď	A A	42	۸A	ΝĀ	A A	ΑN	NA	A S	A S	A N	٧	¥ Z	₹ 2	A N
PRE	c (KSI)	15	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
NCH	×	096.0	1.010	1.055	1.030	1.1ق	1.030	1.050	1.090	1.030	1.030	1.090	1.120	1.070	1.130	1.130	1.080	1.080	1.110	1.080	1.140
DIMENSIONS (INCH)	ಡ	0.255	0.291	0.330	0.304	0.377	0.304	0.320	0.320	0.323	0.320	0.366	0.350	0.332	0.353	0.340	0.330	0.315	0.343	0.344	0.365
DIMEN	ب	10.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
SPECIMEN	₹	6.00	6.00	6.01	9.00	6.00	6.00	6.30	6.00	6.00	6.00	6.00	6.00	9.00	9.00	10.9	6.00	6.00	6.00	6.00	6.00
S E	۳	0.500	0.578	0.589	0.603	0.603	0.604	0.601	0.603	0.600	0.600	0.599	909.0	0.600	109.0	0.600	0.598	0.602	0.600	0.600	0.599
[MAOA	ہے	ہے	ď	يع	4	ď	æ	ہے	ہے	F.	æ	ہے	ہے	یے	ہے	2	7	2	P.	پ
нэ	THICKNESS (IN	1.0	1.0	0.1	1.0	0.1	0.1	1.0	1.0	0.1	1.0	0.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	LD SPECHMEN	AL-8	AS-1	AT:1	AT.2	AD:1	AD-2	ī	H-2	H-3	1	Ę.	Į.,	H-10	X-2	6-1	g Ž	٠.	0-2	0-3	ş

3-1/2% NaCi

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Room Temperature (70 9 F-75 9 F) Surface Flawed Fracture Tests of 2219-T87 Aluminum Alloy. WT Propagation Direction (Continued) Table 26:

_				<u> </u>				<u> </u>										<u> </u>	1	<u> </u>	1
	REFERENCE	2	-	=	=	2	<u> </u>	=	*	7	-	2	=	2	7	=	=	13	5	5	52
	KZI <u>NIM</u> K ^{IE}	38.8	38.5	88	0.88	88	37.7	34.2	36.1	34.5	415	36.1	34.7	37.5	40.0	40.5	8 8 8	35.9	1.94	47.1	39.8
RESULTS	кгі <u>ліи</u> к ^І (Івміи)	36.8	37.6	37.5	6.5%	35.9	35.5	28	31.7	31.6	38.4	34.9	31.7	35.6	37.9	38.5	37.6	33.7	41.9	42.7	7.78
RES	ONET ^{/O} YIELD	080	98.0	0.81	77.0	92.0	0.76	0.59	0.62	3 9.0	0.85	98.0	0.65	18.0	0.82	0.84	0.81	0.76	08'0	0.82	0.756
	(K2I) _O CBO22	43.9	47.7	44.5	42.3	40.8	41.7	30.6	32.3	34.5	46.9	48.5	8	44.5	44.6	46.0	44.5	4 0.8	41.6	42.1	38.7
TEST- ING	(KSI/MIN) BATE COADING	∞ 20	& ≈	% %	% 20	& ≈	%	& %	& ≈	∞ 20	∞ 20	02 ≈	02 ≈	02 ≈	02≈	02 ≈	02≈	02≈	\$	\$	20-30
PREP	PRIOR ENVIRONMENT	AIR	AIR	A.R	AIR	AIR	A B	LH Z	LH ₂ /	LH ₂ /	LH2/AIR	LН ₂ / Аів	гн ₂ /чг	AIR	AIR	AIR	AIR	AIR	AIR	AIR	4
TEST	SOAK TIME (RHUOH)	Ą	Ą	Ž Ž	Ą	₹ Z	٩	A S	Ą	۸A	۷ 2	NA A	۸	A A	A A	۸A	P.A	٩	0.25	0.25	Ą.
NG	(* 1,000) CYCLES	2	5	2	2	2	2	4	2	5	3	15	12	2	2	2	2	4.20	14.0	15.0	\$
PRECRACKING	α	ΑN	A Z	A.A.	AN	A N	Ą Ż	4 2	P.A	NA	NA	NA	A A	٧V	NA	N.	A N	N.	90.0	90:0	90'0
PRE	ر (KSI)	6.72	18.0	27.9	6.72	27.9	27.9	20	20	15	27.9	15	20	27.9	612	6.72	27.9	20-25	5	0	163
	સ	0.912	0.833	0.925	0.947	1.018	0.954	1.385	1.382	1.213	0.945	0.659	1.139	0.854	0.928	0.902	8260	0.944	#	#	1.37
DIMENSIONS (INCH)	ส	0.291	0.228	0.286	0.292	0.323	0.298	0.372	0.368	0.311	0.261	0.215	0.387	0.248	0.306	0.287	0.230	0.257	090.0	0.370	0.340
DIMEN	7	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	a11
IMEN	*	9.00	9.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	00.9	00.9	6.00	7.00	7.00	6.00
SPEC	-	0.652	0.653	0.671	0.650	0.652	0.653	0.656	0.655	0.661	0.658	0.662	0.656	0.604	0.660	0.663	0.645	909.0	0.752	0.752	1.0.1
	FORM	æ	æ	Я	4	.	ď	R	P.	4	4	4	4	P.	4	P.	-	-	ہے	بے	-
(H)	OBICINAL (IN	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.0	0.1	1.0
	I'D Sbeciiwen	C:2	CA-44	7	9-5	C-7	6-3	AA-21	AA-19	AA-61	CA-45	DA-22	DA-20	8-0	c:3	C-1	c-5	SA6-1	2A3R-1	2A3R-2	SBT-20

PREVIOUSLY SUSTAINED AND MARKED

MAXIMUM SUSTAINED GROWTH NOT AT G = 0°

Room Temperature (70 o F–75 o F) Surface Flawed Fracture Tests of 2219–787 Aluminum Alloy. WT Propagation Direction (Continued) Table 26:

													凸	亼	凸	<u>(-)</u>	亼	<u>(-)</u>	<u>(-)</u>		
	REFERENCE	z	n	z	n	a	Z	z	z	2	7.	1.	14	14	14	14	7.	14	14	14	1.
	K2I <u>ΛIN</u> K ^{IE}	43.0	42.4	42.6	42.9	1.14	46.2	45.7	45.9	44.3	37.7	37.2	34.9	39.1	36.6	38.6	37.8	36 1	37.2	39.3	37.4
LTS	кгі <u>ліи</u> к ^і (Івміи)	39.5	38.9	39.3	37.9	40.2	41.9	39.2	41.6	40.2	34.8	35.6	31.6	34.8	35.0	36.7	36.2	34.9	3 €.6	37.5	35.6
RESULTS	ONET ^{/O} YIELD	0.87	0.85	980	67.0	0.86	0.89	080	0.89	0.86	17.0	0.83	0.64	99.0	87.0	0.82	0.83	06.0	0.85	0.85	97.0
	(KZI) Gebore	44.6	43.8	44.5	39.8	9.44	45.8	39.7	45.3	43.8	37.6	46.6	33.8	35.8	42.8	45.4	46.0	50.8	47.7	47.2	43.6
TEST: ING	(KZI/WIN) BATE COADING	AN AN	4 2	٧V	N.	٧Z	ΨN	NA	¥	NA	≈20	∞20	≈20	oz≈	≈20	≈20	≈20	≈20	≈20	≈20	oz.≈
PREP.	PRIOR ENVIRONMENT	OF2	OF ₂	OF2	OF ₂	FLOX	FLOX	FLOX	FLOX	FLOX	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR
TEST	SOAK TIME (ANURS)	٧×	A S	Ą.	A N	۸N	¥ Z	٧V	ΑN	AN	AN A	NA.	NA.	A N	٩	Ą Z	¥ Z	4	₹2	¥	4 2
NG	(* 1,000) CYCLES	42	A N	ΑN	4 2	¥ Z	₹2	٧V	NA NA	NA	4-25	4-25	ı	-	7	2	2	ŀ	1	2	2
PRECRACKING	æ	A N	NA	NA	ΝA	¥ Z	ΑN	NA	NA	NA	NA	NA	NA.	NA	NA	NA	N.A	¥χ	N.A	٧	٧×
PRE	ı: (KSI)	12	12	12	12	12	12	12	12	12	20.25	20.25	22.6	22.6	6.72	6.72	27.9	32.1	32.1	18.0	8.12
(INCH)	2C	1.010	1.020	1.000	1.200	1.080	1.090	1.340	1.080	1.070	1.250	0.772	1.272	1.362	0.872	0.887	608.0	909.0	0.783	0.845	0.892
	3	0.320	0.320	0.320	0.370	0.310	0.325	0.370	0.345	0.365	0.299	0.223	0.324	0.349	0.276	0.241	0.246	0.182	0.190	0.233	0.258
DIMENSIONS	١	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
CIMEN	*	5.97	9009	5.97	6.00	6.00	9.00	9.00	6.00	90.9	9.00	9.00	90.9	90.9	90.9	9.00	6.01	9.00	90.9	6.00	6.00
S& E(,-	0.595	0.596	0.601	0.604	0.602	0.598	0.598	0.597	0.600	0.668	0.667	0.661	0.660	0.661	0.690	0.643	0.668	0.664	0.658	0.656
	ыяоз	R	Ä	R	P	ľ	'n	R	¥	'n	R	R	R	7	4	F.	a.	J.	7	7	٣
СНЭ	ORIGINAL THICKNESS IIN	1.0	1.0	1.0	10	1.0	1.0	1.0	1.0	1.0	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	. 28 1. 28	1.28
	I'D S beciiwen	0F-1	OF-3	0F-2	0F-4	×.1	FX-2	FX-1	FX-3	FX4	AA-2	CA-8	AA-51	AA-1	CA-39	CA-42	CA-10	DA-32	DA-25	C A-4 3	CA-41

PREVIOUSLY SUSTAINED AND MARKED

MAXIMUM SUSTAINED GROWTH NOT AT $\alpha = 0^\circ$

Table 26: Room Temperature (70°F - 75°F) Surface Flawed Fracture Tests of 2219-T87 Aluminum Alloy. WT Propagation Direction (Continued)

	иегереисе	_	72	7,	7,	75	75		l.		,-	9	15	۰,	<u>.</u> ر	15	
L		24	Ž	2	٦	2		*	72	24	9			15	15		13
	(KSI <u>∧ IN')</u> K ^{IE}	41.7	38.6	35.1	36.4	49.2	47.6	49.4	49.3	51.8	44.2	43.7	35.9	36.5	39.3	40.0	36.5
RESULTS	(KSI ∕ IN') K ^I (IBMIN)	32.5	38.1	32.1	33.9	40.5	39.2	38.5	38.4	37.7	42.1	41.4	34.7	35.3	37.3	37.8	35.0
RES	QNET! QVIELD	0.87	0.82	0.76	0.83	0.84	0.82	0.75	0.75	0.72	08.0	08.0	0 67	89.0	0.72	0.73	99 0
	(KSI) O <mark>C</mark> BOSS	44.6	42.7	39.4	43.7	42.0	40.8	37.9	37.8	35.0	43.0	43.5	33.6	33.8	36.9	37.5	35.6
TEST- ING	RATE RATE (KSI/MIN)	Ϋ́	٧	Ą.	Ą	۷N	ΑN	ΝA	ΑN	Ą	06-02	20-30	38	35	38	32	∞ 20
TEST PREP.	PRIOR ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR	AIR									
TEST	SOAK TIME (HOURS)	٩N	ΑN	٧٧	ΑN	٧V	٧V	٧A	NA	NA	ΝA	NA	0.25	0.25	0.25	0.25	٩
NG	CYCLES (x 1000)	10	10	10	91	8	4	2.3	2	3.6	4-6	4-6	5.0	5.0	7.0	8.0	4-20
PRECRACKING	æ	0,24	90.0	90'0	90'0	90'0	90'0	90'0	90'0	90'0	90'0	90.0	90:0	90:0	90:0	90'0	ΑN
PR	(KSI)	12	12	12	12	10	12	10	10	12	9 Z	22	10	10	12	12	20-25
÷	30	0,765	0.980	0,980	0.860	1.380	1,375	1.590	1.590	1.790	1.30	1.31	1.360	1.390	1.475	1.475	1.370
ONS (INCH)	υ	0,178	0.230	0.225	0.205	0.310	0.310	0.345	0.345	0.395	0.360	0.310	0.532	0.545	998:0	0.360	0.364
SPECIMEN DIMENSIONS	٦	0.6	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	11.0	11.0	9.0	9.0	9.0	0.6	8.0
ECIMEN	*	6.00	00'9	00'9	6.00	7,50	7.50	10.00	10.00	10.00	6.0∩	6.00	6.00	5.99	6.00	6.01	6.00
S	Į	0,25	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.90	1.01	1.01	1.097	1.094	1.094	1.096	1.240
	ноя	SHEET	R	P.	7	2	æ	P.	P.	نے	R	P.	Ъ.	F	R	R	F
	(INCH) THICKNESS OBIGINAL	0.25	1,0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.5	2.5	2.5	2.5	1.25
	SPECIMEN 1.D.	RB2-3A	RB5-1A	RB5-1B	RB5-6A	RB5-2A	RB5-2B	RB5-3A	RB5-38	RB5-48	SBT-2	SBT-11	A-5	A-6	A-7	8.∀	SA 12.1

 Table 27:
 Liquid Nitrogen Temperature (-320°F) Surface Flawed Fracture Tests of 2219-T87 Aluminum Alloy.

 RT Propagation Direction

						^	٨			^										•				
		r –	T	T	_				<u> </u>	\triangle	<u></u>	Γ-	r —	Τ	γ	Τ	r	r	1	r	_			}
	REFERENCE	ឌ	a	ន	e	۳	۳	٣	6	e	6	۳	٣	٣	n	n	-	2	٦	۳	۳	۰	•	
	κ2ΙΛ <u>ΙΝ΄</u> Κ ^{ΙΕ}	37.2	38.5	37.8	50 16	52.97	51.70	46.88	43.74	49.14	50.57	17.64	11.64	50.27	47.19	47.34	48.42	52.45	53.38	46.41	50.7	28.2	57.4	
RESULTS	кгі <u>ліи</u> к ^і (Івміи)	36.1	37.4	36.7	44.49	2	36.75	28.34	27.00	73.77	47.67	44.06	79.65	37.40	44.86	44.72	43.91	47.24	45.56	38.14	42.74	1.99	54.6	
RESL	ΟΝΕΤ ^{ΙΟ} ΥΙΈΓD	0.82	0.83	0.83	0.73	0.62	0.51	0.38	0.38	0.30	0.89	0.73	0.58	0.53	0.85	0.82	0.75	18.0	0.75	0.61	99.0	0.89	0.89	
	(KZI) ochose	54.0	54.6	7.3	3	9.8	1.82	21.5	19.7	21.3	5.93	45.6	36.9	33.5	53.4	6.08	45.8	49.3	44.3	37.9	40.7	57.8	1.86.1	
TEST- ING	(KZI\WIN) BATE COADING	٧N	¥ 2	ď Z	4 2	¥ Z	4	₹ Z	42	₹2	4 2	4 2	42	4Z	¥	¥	42	¥	¥	4	¥	20-30	0E-0Z	
PREP.	PRIOR ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	ыч	
TEST	SOAK TIME	٧	۷ 2	ď Z	ď Z	Š	¥ ¥	ď Ž	¥	\$	¥Z	٧N	A N	4	A S	Š	٢	Š	¥	4	ž	٧¥	٧N	
NG	(x 1,000) CYCLES	٧	₹	ď	₹	و 2	ď Z	¥	ş	₹ ¥	¥	٧N	₹ Z	¥	ž	4	٧×	4	ح	4	≨	9+	9+	
PRECRACKING	Œ	٧¥	A A	A X	A A	¥ X	¥ Z	¥ Z	₹ Z	¥	A A	¥	¥	₹	ž	¥.	4 2	ş	خ	ş	ž	0.06	90'0	
PRE	o (KSI)	٧×	₹ Z	¥	≤ 16	<u>\$</u> 16	<u>\$</u> 16	516	≤16	\$16	₹16	€16	§16	\$16	≤ 16	€16	≤ 16	≤ 16	516	516	≤ 16	18	22	
NCH)	20	95.0	95.0	95.0	2.449	3.615	4.610	5.405	5.285	5.525	176.0	1.303	1.750	2.030	0.889	0.964	1.170	1.168	1.370	1331	20.	131	1.26	
DIMENSIONS (INCH)	a	0.20	0.22	12.0	0.272	0.375	0.450	0.525	0.533	0.555	0.247	0.351	0.470	0.555	0.311	0.369	0.432	0.417	0.472	0.546	0.564	0.320	0.230	
DIMEN	۲	11.0	11.0	1.0	20.0	0.02	20.0	20.0	90.0	20.0	10.0	6.0	11.0	0.11	10.0	10.0	30.0	10.0	0.01	0.1	0.11	0,11	0.11	
Z	*	9.00	6.00	6.00	11.0	0.11	14.5	22.0	22.0	22.0	2.50	0.6	12.0	12.0	5.50	5.50	6.75	6.75	6.75	12.0	12.0	6.00	9009	
SPECIM		05.0	0.51	0.51	0.638	0.647	0.633	0.643	0.639	0.643	0.643	0.638	0.642	0.646	0.641	0.637	0.646	0.632	0.630	0.642	9290	1.00	1.00	
	ноям	F.	P.	-	P.	4	-	F	2	یے	N.	'n	ړ	ي	یے	u	,	ہے	ہے	ہے	ہے	J.	ہ	·
СНЭ	ORIGINAL THICKNESS (IN	0.50	0:20	0.50	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.625	0.628	1.00	8.1	3
	SPECIMEN	BSI-1	8SI-2	BSI-3	AB24N-2	AB36N-2	AB45N-1	A 854N-1	AB54N-2	AB57N-2	AB24N-1	AB36N-3	ABASN-3	ABS4N4	AB36N-1	AB36N-2	AB45N-1	AB45N-2	AB54N-2	ABS7N-1	AB57N-2	SBL-17	SBL-12	A

Liquid Nitrogen Temperature (-320°F) Surface Flawed Fracture Tests of 2219-T87 Aluminum Alloy. WT Propagation Direction Table 28:

																					当
	BEFERENCE	21	12	21	2	2	2	2	2	2	2	2	2	2	2	2	2	13	=	2	*
	KSI <u>NIN</u> K ^{IE}	49.0	46.2	6.94	53.0	56.2	56.5	57.1	51.4	47.8	46.9	44.8	43.0	43.3	49.B	52.6	52.0	40.5	41.6	43.3	\$
RESULTS	ka <u>nin</u> K ^I (Ibmin)	44.4	43.0	430	43.9	45.5	42.9	41.7	45.0	38.6	34.1	£12	692	38.6	677	45.0	43.9	37.6	138.1	41.4	4.6
RESI	ONET ^{/O} YIELD	0.87	0.89	0.86	0.83	72.0	0.70	0.66	67.0	0.63	0.53	0.40	0.39	0.43	980	0.85	0.83	0.08	88.0	0.855	0.88
	(KSI) o <mark>CBO22</mark>	53.12	56.00	53.00	45.7	468	41.3	38.1	48.7	30.4	31.1	22.0	22.3	2A.5	51.6	48.4	46.7	1.14	41.7	2	4.8
TEST: ING	(KZI\WIN) BATE FOADING	Š	Ą	Ā	A N	A N	NA	4 Z	¥	¥	NA	N.A	NA	NA.	NA	٧¥	N.	02 ≈	% ≫	2 2	8 %
PREP.	PRIOR ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	2
TEST	SOAK TIME	0.15	0.15	0.15	٧	ž	42	4	٧ ٧	¥ N	Ž	N.	VN	NA	VN	NA	N.	٧V	4	A N	₹
NG	(^ 1,000) CYCLES	18	8	8	ĄZ	٧	٧٧	4 Y	NA	4	NA	¥	NA	NA	NA	V.	٧V	4-20	4-25	4.25	1
PRECRACKING	α	0.1	1.0	2.0	ş	ž	¥.	ž	¥	ş	¥¥	¥	¥Z	NA	NA	NA	NA	NA	NA	NA	4
PRE	ن (KSI)	15	5	51	12	8	8	6 0	&	80	9	9	9	9	15	15	12	20-28	20-25	20-25	32.5
NCH	2	0.945	0.890	0.970	571.1	1.370	1.600	1.720	223	2.85	3.42	4.62	4.36	4.20	0.940	1.080	1.120	1.016	1.238	0.778	0.851
DIMENSIONS (INCH)	· j	0.255	0.200	0.230	0.430	0.333	0.382	0.402	0.220	0.270	0.330	0.425	0.406	0.375	0.360	0.400	0.410	0.274	0.296	0.220	976
JIMENS	J	10.0	0.01	0.01	0,7	14.0	14.0	14.0	21.0	21.0	21.0	21.0	21.0	21.0	0,7	7.0	0.7	9	8.0	8.0	0.8
ECIMEN (\$	6.0	6.0	6.0	5.00	906	906	8.99	12.0	16.0	16.0	20.02	20.0	0.05	5.00	2.00	5.00	9.00	00'9	9009	6.00
SPEC	••	0.5	0.5	0.5	1050	0.500	0.50	0.496	0.502	0.500	0.502	105.0	0.497	0.498	0.501	0.502	005.0	9090	0.0655	0.666	0.649
	мноз	ہے	یے	ہے	ہے	ہے	_	يے	یے	ہے	ہے	یے	ہے	ہے	ہے	ہے	ہے	ہے	ي	ہے	ی
но	THICKNESS (INC	1.0	0.	0.1	0.	0 -	<u>.</u>	0.	0.	0.	<u>.</u>	0.	0.	0.	1.0	1.0	1.0	1.33	1.25	1,34	1.28
	G.I NBLCAMEN	AL-9	AL-10	AL-12	AS54-8	AS52-5	AS52-6	AS52-7	AS51-3	AS514	AS61-5	AS51-6	AS51-7	AS51-8	AS54.5	A364.6	ASSA-7	SA6.2	₽-₩	3	C4-47

PREVIOUSLY SUSTAINED AND MARKED

MAXIMUM SUSTAINED GROWTH NOT AT & - 0°

Table 28: Liquid Nitrogen Temperature (-320ºF) Surface Flawed Fracture Tests of 2219-T87 Aluminum Alloy. WT Propagation Direction (Continued)

					_	_												
	BEEEBENCE	74	PZ	24	54	> 2	24	24	9 2	5 2	54	78	54	77	54	24	24	24
	(KSI / IN')	44.0	46.1	46.3	46.0	45.5	47.6	48.0	52.7	53.2	48.9	49,2	213	50.7	47.2	50.2	38.7	33.3
LTS	(KSI <u>√ in')</u> K [†] (IBMIN)	36.8	38.9	39.3	38.5	37.6	36.6	36.8	43.2	43.7	38.1	38.6	37.7	37.6	32.6	34.9	35.3	30.3
RESULTS	^Q NET ^{IO} YIELD	0.83	0.87	0.89	0.87	0.84	0.78	0.78	0.75	97.0	0.63	0.64	0,59	0.60	0,51	0,55	0.70	0.66
	(KSI) Qebose	53.8	56.9	57.8	56.9	54.9	20,0	50.0	45.1	45.5	37.8	38.6	35.6	938	29.2	31.4	43.7	37.7
TEST- ING	(KSI/MIN) PATE LOADING	ΑN	٧×	٧V	42	٩Z	ΑN	٧٧	٧N	Ϋ́	¥ Z	ΑN	٧V	٧N	УN	NA	٧V	Ą2
TEST PREP.	POIR9 TNAMNORIVNE	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AiR	AIR	AIR	AIR	AIR	AIR	AIR	AIR
TEST	SOAK TIME (HOURS)	Ą Z	Ϋ́	¥ Z	٧	Ϋ́	Ā	Ą.	NA	۸A	٧Z	A A	A S	A.	V.	NA	NA	ΝΑ
S _N	(X 1000) CACFES	14	14	14	4	15	14	14	,	7.5	5.8	5	3.5	3	5	9	25	10
PRECRACKING	Œ	0.24	0.24	0.24	0.24	0.24	0.24	0.24	90.0	90,0	90.0	90'0	90'0	90.0	90.0	90.0	90.0	90.0
P. P.	(KSI)	12	12	12	12	12	12	12	01	10	10	10	12	12	10	10	10	12
	, se	0.805	0.810	0.800	0.665	0.680	0.770	0,765	1.380	1,380	1,580	1,580	1.790	1.780	2.040	2.030	0.960	0,970
S (INCH)	В	0.136	0,132	0.130	0.148	0.154	0,186	0,191	0.315	0.315	0.350	0,340	0,385	0,380	0.430	0.420	0,230	0,235
MENSION	J	9.0	0.6	9.0	9.0	9.0	9.0	9.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.0	9.0
SPECIMEN DIMENSIONS (IN	3	6.00	6.00	6.00	6.00	6.00	6.00	6.00	7.50	7.50	10.00	10,00	10.00	10,00	10,00	10,00	6.00	6.00
SPEC		0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.56	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	МЯОЭ	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	ي	2	2	یے	یے	ي	-	یے	یے	7
	ORIGINA L THICKNESS (INCH)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	8.	1.00	1.8	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	SPECIMEN	NB2-1A	NB2-1B	NB2-1C	NB2-2A	NB2-28	NB2-3A	NB2-38	NB5-2A	NB5-28	NB5-3A	NB5-38	NB5-4A	NB5-48	NB5-5A	N65-58	NB5-1A	NB5-18

Liquid Nitrogen Temperature (-320^oF) Surface Flawed Fracture Tests of 2219-187 Aluminum Alloy. WT Propagation Direction (Continued) Table 28:

_					_					_		_		_
	ВЕЕВВЕИСЕ	14	14	15	15	2	2	9	9	15	15	91	15	13
	K2IΛ <u>IΝ΄</u> K ^{IE}	40.1	38.0	48.4	47.3	26.7	55.9	45.0	49.5	39.9	37.1	41.8	40.7	40.4
RESULTS	k21 <u>/11/1</u> K ¹ (IBMIN)	38.4	36.0	43.8	42.7	48.5	40.5	42.6	47.0	38.7	35.9	39.6	38.5	38.8
RESI	UNET ^{/0} YIELD	0.78	69.0	0.72	0.70	0.73	0.55	69.0	0.74	0.61	0.57	69.0	0.61	0.63
	(KSI) QCBOSS	49.5	43.0	43.4	42.4	43.6	31.0	44.7	47.2	37.4	34.8	39.5	38.6	40.3
TEST. ING	(KSI/WIN) BATE LOADING	∞ 20	∞ 20	64	ફ	ĄZ	٧V	20-30	20-30	35	35	38	35	≈ 20
PREP.	PRIOR ENVIRONMENT	LN ₂	LN2	AIR	AIR	AIR	AIR	⊌IR	AIR	AIR	AIR	AIR	AIR	AIR
TEST	SOAK TIME (SAUOH)	A A	4	0.25	0.25	A A	A A	NA	NA	0.25	0.25	0.25	0.25	A A
NG	(× 1,000) CYCLES	1	1.5	14.0	14.0	Ą	ΑN	4-6	4-6	4.0	5.0	8.0	6.5	4-20
PRECRACKING	Я	NA	A N	90.0	90.0	Ą	NA	90:0	0.06	90:0	90.0	90'0	90.0	NA
PRE	σ (KSI)	32.5	ĸ	2	2	8	8	×	22	10	10	12	12	20-25
INCH)	×	0.795	0.912	1.44	1.44	1.84	2.62	1.34	1.36	1.370	1.370	1.480	1.480	1.341
MENSIONS (INCH)	d	0.241	0.313	0.380	0.380	0.430	0.620	0.320	0.380	0.539	0.540	0.368	0.360	0.342
DIMEN	ب	8.0	8.0	8.0	8.0	14.0	21.0	11.0	11.0	9.0	9.0	9.0	9.0	8.0
SPECIMEN	*	9.00	90.9	7.00	7.00	8.97	12.0	6.00	9.00	6.01	9.00	.6.01	6.01	6.00
SPEC	4-7	0.659	0.650	0.753	0.749	0.751	0.749	1.0.1	1.01	1.102	1.098	1.102	1.18	1.231
	FORM	P	F.	æ	ہے	ہے	ĸ	4	R	2	£	ہے	g.	P.
(HC	THICKNESS (INC	1.25	1.25	1.0	1.0	1.0	1.0	8	9.	2.5	2.5	2.5	2.5	1.25
	SPECIMEN	CA-48	AC-7	2A3N-1	2A3N-2	A572-3	AS72-4	SBT-23	SBT-1	A-1	A-2	A-3	A.4	SA13-2

PREVIOUSLY SUSTAINED AND MARKED

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ო က REFERENCE m m က n n 50.73 K2ΙΛ<u>ΙΜ΄</u> Κ^{ΙΕ} 50.56 54.15 8.8 51.06 52.06 53.09 52.62 46.29 46.53 49.23 47.88 45.32 KZININ 47.77 45.99 46.81 RESULTS KI (IBMIN) 0.75 0.83 0.86 0.77 0 79 0.70 0.71 $_{0}$ NET $_{10}$ XIEFD (KZI) 49.6 49.7 **6**.99 49.9 **4** 3.3 54.7 51.2 44.8 SSOND (KSI/WIN) BATE FOADING ES S ٤ Š ٤ ş ≨ Š ž ş TEST PREP. ENVIRONMENT PRIOR AIR AR AIR AR AIR AR AR Ā (HOURS) ۲ ž ۲ ž ž ž ž ž (× 1,000) CYCLES Ž ž Š ۲ ۲ ۲ ₹Z ٤ PRECRACKING ٤ ž Š Œ ٤ ž ž ş Ž **≥** 16 ð1 ≽ **≥** 16 **≱**16 **6**16 **№** (KSI) **≥** 16 **≥**16 O 1.176 SPECIMEN DIMENSIONS (INCH) 2.425 2.430 0.956 0.930 1.161 1.361 1.371 g 0.225 0.228 0.476 0.355 0.352 0.422 0.410 0.476 d 10.0 10.0 10.0 10.0 10.0 10.0 6.0 6.0 ب 9.00 6.75 6.75 9.00 5.50 5.50 6.75 6.75 ₹ 0.643 0.644 0.642 0.647 0.625 0.633 0.627 0.641 FORM 4 ہے 4 ď 뻔 굍 ď ۳ LHICKNESS (INCH) 0.625 0.625 0.625 0.625 0.625 0.625 0.625 0.625 DRIGINAL AB24H-2 AB36H-1 AB45H-1 4824H-1 AB36H-2 AB45H-2 AB54H-1 AB54H-2 I'D' Sbecimen

Liquid Hydrogen Temperature (-423°F) Surface Flawed Fracture Tests of 2219-T87 Aluminum Alloy.

RT Propagation Direction

Table 29:

V ≥ × ×

Liquid Hydrogen Temperature (-423^oF) Surface Flawed Fracture Tests c† 2219-T87 Aluminum Alloy. WT Propagation Direction Table 30:

							Δ	Δ	Δ		\
	REFERENCE	14	14	14	15	15	15	15	15	15	
	κει <u>Λιη:</u> Κ ^{ΙΕ}	45.3	45.5	44.3	52.1	52.5	1.4	44.9	46.6	48.1	
RESULTS	к2і <u>λіи:</u> к ¹ (івміи)	41.0	43.5	43.2	47.2	47.5	42.4	43.2	44.2	45.6	
RES	UNET ^{\U} YIELD	0.65	08.0	0.88	0.74	97.0	39.0	99.0	690	1/2/0	
	(KSI) neboss	1.44	56.5	63.6	46.7	46.8	42.5	43.2	47.0	48.7	
TEST- ING	(KSI/WIN) BATE COADING	90	20	20	40	40	45	45	45	45	
PREP.	PRIOR ENVIRONIMENT	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	
TEST	SOAK TIME	۸×	ΑN	Ą V	0.25	0.25	0.25	0.25	0.25	0.25	
NG	(^ 1 ² 000) CACEE2	4-25	4-25	4-25	15.0	14.0	5.5	5.0	7.0	6.0	
PRECRACKING	Ж	۲ ک	٧	۷ ۲	90:0	90:0	90.0	0.06	90.0	90.0	
PRE	ı: (KSI)	20-25	20-25	20-25	0	10	10	10	12	12	
INCH)	20	1.219	0.789	0.600	4.	1.44	1.285	1.285	1.310	1.310	
SIONS (INCH)	73	0.333	0.229	0.174	0.37.	0.384	0.480	0.480	0.313	0.305	
SPECIMEN DIMENS	-1	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	
IMEN	۸i	6.00	6.00	9.90	7.00	7.00	5.00	5.01	5.00	5.00	
SPE	-	0.650	0.657	0.689	0.750	0.751	1.002	00	1.00	1.004	
	новы	я.	یے	ہے	ہے	ہے	ہے	ď	یے	F	•
сн)	ORIGINAL THICKNESS (IN	1.25	1.25	52	0.1	1.0	2.5	2.5	2.5	2.5	۷ <u>*</u>
	SPECIMEN	AA-4	CA-9	DA-16	2A3H-1	2A3H-2	A-9	A-10	A-11	A-12	<u>^</u>

Liquid Nitrogen Temperature (-320°F) Surface Flawed Fracture Tests of GTA Welded 2219-T87 Aluminum Alloy. Square Butt Weld Edge Preparation. No Filler Wire. No Post Weld Heat Treatment Table 31:

	ВЕГЕВЕИСЕ	3	3
	K2IΛ <u>ΙΝ΄</u> Κ ^{ΙΕ}		
RESULTS	K2I <u>/III'</u> K ^I (IBMIN)	31.49	24.69
RES	^ט אפד ^{/ט} אופּעס	0.82	69.0
	(KSI) _Q GBOSS	19.8	15.4
TEST- ING	(KZI/WIN) BYTE LOADING	NA	A N
TEST PREP.	PRIOR ENVIRONIMENT	AIR	AIR
TEST	SOAK TIME	NA	AN.
NG	(× 1'000) CACFE2	NA	NA
PRECRACKING	8	NA	A'S
PRE	ر (KSI)	∞ 10	∞ 10
INCH;	20	4,245	5.035
MENSIONS (INCH)	ø	0.710	0.735
DIMEN	١	92	92
SPECIMEN	*	24.0	30.0
SPE(4	1.018	1.037
	мяоэ	R	R
СНЭ	OBIGINAL THICKNESS (IN	1.00	1.00
	I'D' Sbeciwen	1AW63N-2 1.00	1 AW75N-3 1.00

Liquid Hydrogen Temperature (-423º F) Surface Flawed Fracture Tests of GTA Welded 2219-TB7 Aluminum Alloy, Square Butt Weld Edge Preparation. No Filler Wine. No Post Weld Heat Treatment Table 32:

	REFERENCE	3	3	3	3	3	3	е	3
	K2Ι <u>ΛΙΝ΄</u> _Κ ΙΕ								
RESULTS	K21 <u>/11/</u> K [†] (IUMIN)	18.48	12:32	21.50	19.41	26.58	62.82	02.72	24.91
RES	ONET ^{/O} YIELD	0.49	09.0	0.49	0.41	0.70	17.0	99.0	0.61
	(K2I) _Q ebo <i>2</i> 2	14.3	17.3	14.3	11.6	20.8	20.7	18.8	17.0
TEST- ING	(KZI\WIN) BATE LCADING	NA	NA	NA	NA	NA	٧¥	NA.	NA
TEST PREP.	PRIOR ENVIRONIMENT	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR
TEST	(HOURS)	A N	A A	N.A	Ą	A A	Š	¥ ¥	A A
NG	(× 1,000) CYCLES	NA	Ą	AN AN	A N	۷ ۷	A N	4	٧
PRECRACKING	Œ	٧V	AN A	N.A	AN	٩٧	Ą	¥ ¥	Ą
PRE	σ (KSI)	∞ 10	≈ 10	≈ 10	≈ 10	≈ 10	∞ 10	≈ 10	≈ 10
INCH)	8	3.355	4.165	4.215	5.970	2.335	2.490	2.895	2.985
DIMENSIONS (INCH)	a	0.500	0.620	0.700	0.840	0.710	0.775	0.835	0.870
DIMEN	-	20	8	56	82	8	8	8	20
SPECIMEN	*	0.01	20.0	24.0	30.0	13.5	16.0	16.0	16.0
SPEC	+	1.002	1.010	1.016	1.010	1.014	1.007	986.0	1.000
	РОВМ	4	R	بے	5	یے	ہے	. L	
(на	ORIGINAL (INC	1.0	1.0	1.0	1.0	1.0	0.1	1.0	1.0
	SPECIMEN	1-HOSMY1	1 AWE3H-3	1AW75H-1	1AW90H-3	3AW75H-3	3AWB3H-3	3AW9OH-3	3AW96H-3

Wov.
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19-T87 Alun
of 2219-T8
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oad Te
tained L
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–75º F) Surta
F-750
ire (70º F.
<i>semperatu</i>
Room
Table 33: Ro

1	REFERENCE	8	28	T (%	æ	8	æ	9	9	9	9	8	8	2	=	2	7	:	4	1	
t									 			-				\vdash			 -		
	ENTS																				
	COMMENTS	\triangle								URE									\triangle		
	0	NF	Ä	N F	¥	Υ.	ž	S _Z	S _Z	FAILURE	NG	발	T Z	Α. H	Sg	ŭ.	A N	Sg	§2.		
:[(K21 \(\lambda \)				1			40.6	40 5	443	40.8	39.4	88	39.3	16.5	26 4	33.3	17.6	23.3		
	(KZI <u>(IUMIN)</u> K ^{II} (IUMIN)			1		1		38.4	38 6	42.2	39.0	37.0	368	369	164	28.1	31.8	16.8	22.2		
یا	(KŽIĄ INT)	21.0	23.0	22.4	21.3	22.0	21.9	40.6	40.5	43.2	40.8	20.	38.7	380	16.5	263	32.9	17.6	23.3		
FSI II TS	(KZI <u>(IN)</u> K ^{II} (IBMIN)	18.9	20.4	8	19.1	19.7	19.8	38.4	988	4	98.0	36.8	36.6	36.6	16.4	25.0	31 4	16.8	22.2		
ă		67.1	68.4	22.0	1.79	88	72.0	32.50	2	90	24.0	2/1	1.0	20.0	1.0	1.0	10	1.0	1.0	ر. <u>خ</u>	
	(INCH) 5C ^l	Z A	٩	Ž	Ž	Ž	ک	,	1	1.28	,	0.925	0.925	0.915	0.178	218 0.834	0.876	0.828	0.887	END	
	(INCH) ช ¹	0.063	0.073	0.078	0.063	0 064	0.077			0.356		0.26009	0.25	0.259	0.05	0.218	0.272	0.175	260	PRECRACKED IN BENUING	Ğ
UN.		0.82	0.85	0.85	0.82	0.84	0.84	98	980	0.84	0.87	0.80	080	0.80	0.78	0.57	0.68	041	0.480.260	CKE	10% NaOH ETCH
TESTING	(KSI) (MAX	45.0	46.7	46.7	45.0	46.2	46.4	38.5	41.6	43.3	42.8	2.5	41.5	44.5	45.0	33.0	88.	23.7	27.9	ECRA	New Sec
ST	ENVIRONMENT	AIR	AIR	AIR	A	A	A	H	AIR	AIR	AIR	AIR	AIR	AIA	AIR	AIR	LN2	A R	LN2	Y PR	_
TEST	(HOURS)	Ą Z	A A	¥ Ž	Š	A A	4 Z	ď Z	42	₹ Z	Ž	A A	Z Z	A A	Ą	4	۷ ۲	<u>د</u> 2	ď Z		
NI N	(* 1000) CACEE2	٩V	NA	ž	ž	<u>د</u> 2	4	94	4-6	4-6	4-6	A A	₹	Ą Z	9	G	15	7	9		
RAC	Œ.	A A	NA	Š	Ą	Ą Z	۷ Z	<u>ل</u> 2	۲ ک	Z Z	A A	A N	Υ Z	Ą Z	A N	Š	Š	۷ 2	٧N	0	
PREC	(K Si	8	8	8	8	8	8	120	8	8	ĸ	12	12	12	30	15	8	15	27.9	DIO	
IONS (INCH) PRECRACKING	%	0.245	0.264	0.253	0.254	0.252	0.252	1.4.1	1.32	1.28	1.26	C.925	0.925	0.915	0.178	0.834	0.872	0.828	0.887	GROWTH DID NOT	AT $a = 0^{\circ}$ PREVIOUSLY
ONS	3	0.063	990.0	0.065	0.063	0.064	0.063	0.32	0.28	0.31	0.27	0.252	0.243	0.249	0.051	0.214	0.258	0.175	0.260	UM GRO	AT Q.
		Š	A A	Ą	ş	₹ ¥	<u>ح</u>	=	=	=	=	8.0	8.0	8.0	8.0	8.0	08	8.0	8.0		
EN D	3	1.504	1.504	1.502	1.506	1.518	1.509	0.9	0.0	0.9	0.9	00.9	5.98	e.00	00.9	6.00	9009	00.9	00.9	W △	OCCUR.
SPECIMEN DIMENS	-	0.1257	0.1252	0.1252	0.1257	0.1255	0.1257	1.0.1	10.1	1.0.1	1.01	909.0	0.607	0.591	0.653	0.650	0.650	0.661	0.661		<u>(</u>
	PROP SETION DIRECTION	o ¥	WT	WT 0	o ₹	WT	WT	WT	- A	WT 1	WT 1	o ₩	WT 0	WT 0	WT 0	WT 0	o ₩	WT 0	WT 0		m
	16: 0d	FS	Ŧ	HS	FS	HS	SH	F.	4	4	F.	4	5	-	5	. J	٦.	٦	5		E C
	THICKNESS (INCH)	0.125	0.125	0.125	0 125	0.125	0.125	1.0	0.1	1.0	1.0	1.0	0 !	1.0	1.25	1.25	1.25	1.25	1.25	TEST	NO FA
	I D SPECIMEN	21T	24T	25T	72T	23T (26T (SBT-3	SBT-12	SBT-13,	SBT-14	AR-2	AR-3	AR4	1-35	AC-7	AC-7	AC-8	AC-8	INLOAD	H WITH
	ENAIBONWENT	AIR	-								-6,-	,						- 3	,	L/U = LOAD/UNLOAD TEST	NF # GROWTH WITH NO FAILURE NG = NO GROWTH

TESTED PREVIOUSLY

Table 33: Room Temperature (100 F--150 F.) Surface Flawed Sustained Load Tests of 2219-T87 Aluminum Alloy (Continued)

	BELEBENCE	14	14	14	14	14	14	14	14	14	14	14	14	14	14	41	4	4	4
	COMMENTS	JRE 1	\triangle		<u>^</u>		RE (>)	RE		\sim	 ⟨	Δ		Δ					Δ
	00	FAILURE	NF	N.	N T	n N	FAILURE	FAILURE	NF	NF	NF	Ā	Ŗ	Ŗ	ΑN	n T	Ā	S	Z H
П	(KSI √IN)	_	32.3	36.7	32.9	35.7		ı	31.0	34.0	36.5	26.9	34.5	34.3	33.7	23.8	32.6	25.7	32.3
	(K21 <u>\(IM)</u> K ^I ! (IBMIN)	-	29.4	32.7	31.4	34.0			29.6	32.4	34.9	25.7	32.8	32.8	32.6	23 1	31.0	24.5	30.7
	(KSI <u>V IN.)</u>	35.6	31.7	33.9	32.6	35.6	38.0	35.8	30.6	33.4	36.1	26.8	34.5	33.9	32.2	23,4	32.4	25.7	32.1
ESULTS	(K2I ,\ <u>IM)</u> K ^{II} (IBMIN)	32.2	29 0	31.0	31 1	33.9	36.2	34.3	29.2	31.9	34.6	25.6	32.8	32.4	31.4	22.7	30.8	24.5	30.5
RES	NOITARUG (SRUOH)	0.1	15.3	38.6	24)	20.3	0.7	6.0	19.0	21.5	1.6	17.2	4.6	38.1	24.0	14.2	23.7	15.6	0.02
	(INCH)	,	.253	88		50.818	:	i	0.771	811	0.829	0.779	0.851	0.77838.1	0.603	0.603	0.338	0 8051	0.813
	(INCH)		0.3101.	0.3471	0.2100.775	0.2150			0.216	0.229C	0.243(0.202	0.228	0.228	0.176	0.176	0.225	220	223
N.G	U MAX ^{IO} YIELD	93.0	0.52 C	0.58	0.72	0.76	080	0.74	0.68	0.72	0.760	0.60	0.720	0.740	0.830	0.60	0.69	0.560.	0.690
TESTING	(KZI) (MAX	33.8	32.0	33.8	41.9	44.2	46.5	43.0	39.5	41.9	44.2	93.	41.9	43.0	48.1	34.8	40.0	32.5	40.0
\vdash	PRIOR ENVIRONMENT	AIR	A-R	AIR	H.	AIR	A.R	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR
TEST PREP	(HOURS)	۷ ۷	Ą Z	₹ Z	₹ Z	ď Z	4 2	Ą Z	4 Z	₹ Z	Ą Z	Ϋ́	۷ Z	A Z	ΑN	٧V	NA A	AN A	Ϋ́
SUIV	(× 1000) CACFE2	4	3	8	6	-	-	52	5	-	-	=	2	12	14	10	18	13	15
ECRACKING	Œ	Ą	<u>د</u> 2	₹ Z	₹ Z	<u>ح</u>	₹ Z	A A	S A	₹ Y	Š	Ą Z	۲ 2	Š	NA	Ϋ́	NA	۸A	Z A
PREC	U (KSI)	15	55	5	15	27.9	27.9	5.	15	27.9	27.9	15	27.9	15	15	51	15	15	15
ONS (INCH)	2C,	1.317	1.210	1.191	0.763	0.815	0.816	0.831	0.761	0.785	0.810	0.779	0.851	0.766	0.560	0.597	0.833	0.805	0.813
	α,	0.335	0.304	0.322	0.205	0.212	0.224	0.263	0.207	0.225	0.240	0.200	0.226	0.217	0.161	0.165	0.219	0.220	0.215
MENS		8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
SPECIMEN DIMENS	8	6.0	6.00	6.00	6.00	6.00	90.90	9.00	6.00	6.00	6.00	9.00	6.00	6.01	9.00	9.00	9.00	9.00	6.00
SPECIA	¥	0.668	0.661	0.660	0.665	0.665	0.665	0.656	0.661	0.661	0.661	0.680	0.680	0.643	0.668	0.664	0.658	0.656	0.604
T	NOITOPAGATION NOITOBRIO	ž	ž	ž	¥	¥	¥	¥	¥	¥	¥	¥	¥	ž	¥	¥	¥	¥	WŢ
	мяоз	굍	٦.	4	ہے	4	چ	4	- 2	ద	2	æ	æ	ها	æ	2	4	ہے	4
(1	THICKNESS (INCHOPLICE)	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
	SPECIMEN	AA-50	AA-51	AA-1	CA-37	CA-37	CA-37	CA-12	CA-39	CA-39	CA-39	CA-42	CA-42	CA-10	DA-32	DA-25	CA-43	CA-41	C-8
	ENVIRONMENT	AIR (Cont)																	

AILURE \bigcirc MAXIMUM GROWTH DID NOT OCCUR AT $a=0^\circ$ \bigcirc TESTED PREVIOUSLY

NF = GROWTH WITH NO FAILURE NG = NO GROWTH

Table 33: Room Temperature (70° F-75° F) Surface Flawed Sustained Load Tests of 2219-T87 Aluminum Alloy (Continued)

	REFERENCE	14	14	14	14	14	14	14	14	14	14	14	2	5	5	2	22	9	g
	COMMENTS	Δ								<u>^</u>									FAILURE
L			ΝF	Z T	Z L	N L	NG	Ľ Z	N T	N.	N.	Z L	Z L	NF	N	Ä	N H	NG	
	(K21 \	33.5	19.3	19.5	19.0	29.5	22.5	33.5	33.2	33.4	33.4	32.4	34.5	34.5	37.3	31.1	39.2	39.4	465
	(KZI <u>/ IN')</u> K ^I I (IBMIN)	32.0	18.4	18.7	18.2	28.8	22.2	32.1	31.7	31.9	31.9	30.9	32.6	32.6	34.7	7 62	36.9	37.4	43.7
S	(KŽIĄ IN')	33.4	19.1	19.4	18.9	29.4	22.5	33.4	33.0	33.4	33.3	32.3	84 3	34.1	36.6	31.0	39.1	39 4	41.6
RESULTS	(K\$1 <u>\ IN')</u> K (IUMIN)	31.8	182	18 5	180	28 7	22.2	32.0	31.5	31.8	31.7	30.7	32.4	32.3	34.2	9 62	36 7	37.4	39.4
RE	NOITARUD (BAUOH)	1.33	1.00	4.70	30.00	1.0	1.0	90.0	0.17	0.33	29'0	1.00	٦/١	10.0	10.0	10.0	16.0	24.0	1.75
	(INCH) SC ^t	0.861	0.858	0.867	0.83430.	0.561	0 372	0.851	0.846	0.860	0.853	0.831	0.570	0.568	0.652	0.470	0 920	ì	1.54
	(INCH)	0.256	0.247	259	238	0.150	960	265	0.248	0.250	0.256	0.223	0.148	0.149	0.183 0.652	0.125	253	1	0.45
-NG	MYX _{\Q} LIEFD	0.69	0.41	0.41 0	0.41 0	0.78	0.78 0.	0.69	0.69	0.69	0.69	69.0	0.90	06.0	0.88	060	0.80	0.87	0.81
TESTING	(K2I) QWPX	40.0	23.7	23.7	23.7	45.0	45.0	40.0	40.0	40.0	40.0	0.04	50.0	50.0	49.2	0.03	44.6	39.7	40.7
ST EP.	PHIOR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR
TES	(HONUS)	۸Ā	٩V	٨	٨	۸A	٧Z	٨N	٧V	AN	A A	۲ ۲	Ą	ΑN	ΑN	٩	ΑN	ΝA	Ą
ACKING	(× 1000) CACFE2	17	15	15	15	9	9	20	15	15	15	81	δ A	ΝA	NA	NA	NA	4-6	4-6
CRACK	æ	A A	ΑN	٧V	٩	NA	٧×	٧V	ΔN	ΑN	Ϋ́	Ϋ́Z	<u>د</u> 2	۸N	ΝA	ΑN	٧V	NA	۲ ۲
PREC	σ (KSI)	15	15	15	15	20	25	15	15	15	15	15	ž	NA	NA	N.A	12	25	25
(INCH)	×	0.858	0.847	0.861	0.828	0.561	0.322	0.848	0.843	0.860	0.853	0.830	0.570	0.568	0.649	0.470	0.920	1.29	1.37
ONS	a,	0.248	0.236	0.252	0.233	0.148	0.095	0.262	0.241	0.245	0.247	0.218	0.143	0.191	0.169	0.121	0.249	0.31	0.32
DIMENS	ب	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	7.0	7.0	7.0	7.0	8.Ď	11	=
	3	6.00	00'9	00'9	6.00	00.9	6.00	00.9	6.00	00:9	6.00	6.00	5.002	5.004	5.006	5.005	6.00	6.0	0.9
SPECIMEN	~	0.671	0.656	0.652	0.653	0.655	0.653	0.660	0.663	0.645	0.652	0.663	0.400	0.399	0.402	0.405	0.598	1.0.1	1.01
	PROPAGATION DIRECTION	¥	¥	W	¥	W	W	M	¥	¥	¥	₹	ş	¥	¥	¥	¥	ş	Ĕ
_	FORM		4	4	<u> </u>	4	4	<u>بر</u>	.c	4	.c	4	۳.	4	4	4	권	H	굍
L	THICKNESS (INCI	1.25	1.25	1 25	1.25	1.25	1.25	1.25	1 25	1.25	1.25	1 25	0.	1.0	1.0	1.0	1.0	1.0	1.0
	SPECIMEN I.D.	3	C-6	6.7	65	C8-1	C6-1	C-3	<u>ن</u>	C-5	C-2	CA 44	A3A-27	A3A-26	A3A-28	A3A-30	AS-1	SBT-18	SBT-15
	TN3MNORIVN3													3-1/2% NaCL					

 \bigcirc MAXIMUM GROWTH DID NOT OCCUR AT $a=0^{\circ}$

L/U = LOAD/UNLOAD TEST

NF = GROWTH WITH NO FAILURE

NG = NO GROWTH

Tabie 33: Room Temperature (70º F.-75º F) Surface Flawed Sustained Load Tests of 2219-T87 Aluminum Alloy (Continued)

BEFERENCE		22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	9	9
COMMENTS		NF	NF	NF	NF	NF -	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	FAILURE	FAILURE
ESULTS	(KSI <u>\ IM</u>) K l i	38.9	38.8	39.6	39.2	39.9	37.4	38.9	38.6	38.9	39.2	38,5	39.3	39.5	39.9	36.9	39.4	39.4	45.4	51.0
	(KZI <u>/ IN)</u> K ^I I (IBMIN)	36.7	36.6	37.2	36.9	37.4	35.0	36.7	36.4	36.6	36.8	36.2	36.9	37.1	37.3	34.7	37.0	37.0	43.2	48.4
	(KŽI <u>A IN')</u>	38.8	38.7	39.4	39.0	39.6	37.2	38.8	38.5	38.6	39.0	38.2	38.9	39.1	39.7	36.7	39.1	39.1	43.7	51.0
	(KZI <u>AIN')</u> K ^{II} (IBMIN)	36.6	36.5	37.0	36.7	37.2	34.9	36.6	36.3	36.4	36.6	36.0	36.6	36.8	37.2	34.6	36.8	36.7	41.5	48.4
RE	NOITARUD (SRUOH)	10.0	10.0	16.0	27.1	150	16.1	10.0	8.0	0.3	11.0	10.4	ר/ח	1.0	16.2	15.7	10.0	12.0	0	0.01
	(inch) SC [‡]	0.920	0.920	0.925	0.925	0.925	0.930	0.920	0.915	0.915	0.925	0.915	0.925	0.925	0.923	0.925	0.930	0.920	1.33	i
	(INCH)	0.2460.920	0.2430.920	0.80 0.263 0.925).251	0.80 0.274 0.925	0.2690.930	0.80 0.246 0.920	0.80 0.240 0.915	0.2460.	0.2490.	0.2490.915 10.	0.2560.	0.2620.925	0.2690	0.2570925	0.2550.930	0.2580.920	0.38	ı
ESTING	MAX VOYIELD	0.80	0.80	0.80	0.80 0.251	0.80	0.76	0.80	0.80	0.80	08.0	080	0.80	0.80	0.80	0.76	0.80	0.80	0.84	0.76
TEST	(KSI)	44.6	44.6	44.6	44.6	44.6	42.0	44.6	44.6	44.6	44.6	44.6	44.5	44.5	44.6	42.0	44.6	44.6	43.3	49.8
EP	ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR
TEST PREP	(HOURS)	ΑN	Ϋ́	۲ ۲	A A	A N	AN	A N	NA	A A	A	A	A A	A A	Ą	۸N	Ą	Ą	A A	Ϋ́
KING	(× 1000) CACLES	S	٧Z	Ą Z	A A	Ϋ́	NA	Ą Z	۸N	ΝA	NA	۸N	A S	S A	Z A	Z A	A A	S	4-6	4-6
PRECRACKING	α	۲ ک	Ϋ́	A A	A A	A S	A A	A A	A A	AN	A A	AN	4	A A	A A	Ą	Ā	Ą	Z Z	ξ Š
PREC	(K SI)	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	55	52
(INCH)	Ŕ	0.920	0.920	0.925	0.925	0.925	0.930	0.920	0.915	0.915	0.925	0.915	0.925	0.925	0.923	0.925	0.930	0.920	1.33	1.29
NSIONS (ä	0.243	0.240	0.255	0.246	0.264	0.264	0.243	0.237	0.240	0.243	0.243	0.246	0.252	0.264	0.252	0.246	0.249	0.31	0.32
DIMENS	_	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	0.3	8.0	8.0	8.0	11	Ξ
MEN D	3	9.00	9.00	6.00	6.00	9.00	9.00	00.9	6.00	6.00	5.97	6.00	9.00	9.00	6.01	6.00	6.00	9.00	6.0	9:0
SPECIMEN		0.601	0.603	0.600	0.605	0.603	0.604	0.602	0.598	0.598	0.595	0.596	0.604	0.610	0.589	0.603	0.602	0.600	1.0.1	9.
	NOITADA9OR9 NOITOBRIO	ž	₹	ž	ž	ş	₹	ž	ş	ž	ķ	ş	ž	ž	₹	¥	¥	ž	¥	H.
ьоям		굍	권	4	4	4	4	4	4	P.	4	R	굍	4	æ	권	4	ď	4	굍
THICKNESS (INCH) OBIGINAL		0.	0.	0.	0.	0 -	0.	0.	1.0	1.0	1.0	1.0	0.:	0.	1.0	1.0	0.1	0.	0.	o.
I'D' Sbecimen		ΕΞ	H-2	AW-1	AW-2	AD-1	AD-2	×	FX-2	FX-1	0F-1	0F-3	AA-1	AA-2	AT-1	AT-2	ö	0-2	NBT-19	NBL-20
ENVIRONMENT		GH ₂		DISTILLED H20		DYE PENETRANT		FLOX			OF ₂		ARGON		TRICHLORO-		GO2		172 dB NOISE LEVEL	

NLOAD TEST OADED TWICE, ONCE FOR 5 HOURS AND ONCE FOR 10 HOURS

L/U = LOAD/UNLOAD TEST NF = GROWTH WITH NO FAILURE

Table 33: Room Temperature (700 F - 750 F) Surface Flawed Sustained Load Tests of 2219-T87 Aluminum Alloy (Continued)

	BELEBENCE	24	24	24	24	24	24
	COMMENTS	NF [>	NF 🌅	NG [>	NF [>]	NF [>[>	NF [>
	(KSI A INT	33.2	31.6	23.0	35.5	36.0	36.9
	KRELA <u>IM)</u> K ^{IŁ} (IBMIN)	30.9	29.5	21.5	33.1	33.6	34.5
S	(KSI VIN.)	32.9	31.4	23.0	35.4	35.7	36.7
RESULTS	(KSI /\ IN')	30.7	29.3	21.5	33.0	33.3	34.2
æ	NOITARUD (SRUOH)	44.8	29.1	90.6	22.9	18.1	20.4
	(іисн) se ^į	0.73 0.206 0.860	38.5 0.70 0.204 0.860	0.53 0.189 0.860	0.79 0.190 0.860	43.5 0.79 0.202 0.860	44.6 0.81 0.200 0.860
	(INCH) 0 [‡]	206	.204	0,189	0.190	202.0	.200
NG NG	OMAX ^{IO} YIELD	0.73	0.70	0.53	0.79	0.79	0.81
TESTING	(K2I) (WAX	40.1	38.5	1.62	43.5	43.5	44.6
TEST	PRIOR ENT	AIR	AIR	AIR	AIR	AIR	AIR
HE	SOAK TIME (HOURS)	۷ ۷	ş	٩	Ş	٧Z	۷ ۷
GING	(× 1000 CACLES	15	25	12	4	8	15
RACK	Œ	Ą Z	₹ Z	۷ ک	₹ Z	₹ Z	∀ Z
PRECRACKING	σ (KSI)	12	01	12	20	8	12
	2C,	0.860	0.860	0.860	0.860	0.860	0,860
IONS (INCH)	a,	0.202	0.200	0.189	0.189	0.195	0.195
MENS	7	10.0	10.0	0.0	0.0	10.0	10.0
SPECIMEN DIMENSI	*	00.9	6.00	6.00	6.00	90.9	9.00
SPECIF	+	0.50	0.50	0.50	0.50	0.50	0.50
		ž	¥	ş	¥	¥	¥
	FORM	یے	4	ہے	ئے	ہے	냎
(1	THICKNESS (INCH	1,0	1.0	1.0	0.1	1.0	1.0
	I'D' S b ECIWEN	SR85-1	SRB5-2	SRB5-4	SR85-4	SR85-4	SR85-5
	ENVIRONMENT	AIR				 	

Table 34: -230° F Temperature Surface Flawed Sustained Load Tests of 2219-T87 Aluminum Alloy

_					_	
		REFERENCE	9	9	9	
		COMMENTS	NG	NG	NG	
Ì		(K2I \\ IM') KIEL	18.7	90.4	52.1	
		(KSI ∱ IN')	5.3	48.1 50.4	49.4 52.	
		KIŁ (IBMIN)	4	₹		
١	2	KIE!	8.	8	52.	
I	RESULTS	(KRI <u>(IN')</u> K ^{II} (IBMIN)	46.3	1.8	49.4	
I	RES	(SHUOH)	24,0146.3 48.7 46.3 48.7	18,30 48.1 50.4	4.74 49.4 52.1	
ı		(HONI) NOITARUO	Ÿ	<u>=</u>	,	
۱		SC ^t	┞┤			
		(INCH)	1	i		
I	ING	O MAX OVIELD	0.85	0.86	0.80	
	TESTING	(K2I) (MAX	49.1	51.7	51.7 0.80	
Ì		PRIOR ENVIRONMENT	4 2	NA 51.7 0.86	Ą Z	
	TEST PREP	SOAK TIME	۷ 2	Ą	₹ Z	١
ł	NG	(0001 ×)	4-6	4-6	9-4	ľ
	ICK	CACFE?	δ A	¥ Z	4 Z	
	ECR.		\vdash		0	
	PR	σ (KSI)	25	.55	25.0	ļ
	IONS (INCH) PRECRACKING	, ,	1.29	1.28	1.30	
	SIONS	α,	0.30	0.28	0.31	
	MEN	-	Ξ	11	=	
	SPECIMEN DIMENS	8	9.0	6.0	9.0	
	SPECI	4	1.00	1.00	9.	
		PROPAGATION NOITSERION	ВТ	ЯT	пТ	
		мяоз	ď	٦	٦	
	()	THICKNESS (INCHOBICINE)	1.0	1.0	1.0	
		SPECIMEN I.D.	NBL-28	NBL-21	NBL-24	
		ENVIRONMENT	172 dB NOISE LEVEL			

NG - NO GROWTH

	REFERENCE	2	2	2	2	4	=	7	1	4	4	4	4	14	4	4	4	<u> </u>	7	
	COMMENTS		\triangle			URE	<u> </u>			JRE	Δ	\triangle	\(\frac{1}{2}\)	Δ		URE	<u>^</u>		\sim	
	Ö	Z F	ΑN	A.	Ä	FAILURE	Z T	FAILURE	S _N	FAILURE	Ä	A N	FAILURE	NA H	A.	FAILURE	n Z	NG	F.	
	(K2I <u>\ IM`)</u> K ^{[[}	40,4	48.3	36.0	40.2		8.68		38.3	1	38.8	42.6	ı	41.8	39.4		39.8	23.5	31.8	
	(KZI <u>/ IN')</u> K ^{IL} (IBMIN)	38.5	44.2	34.5	1.88.		35.8	ŧ	35.1		37.0	40.7	ı	39.8	38.1		38.6	22.5	29.6	
s	(K21 <u>\/ IN')</u> K ^{I!}	1.04	41.5	35.8	40.0	39.8	36.9	42.2	38.3	39.3	38.4	41.9	45.4	41.0	39.3	40.0	38.0	23.5	31.6	
ESULTS	(KŞI <u>(IN')</u> K ^{II} (IBMIN)	38.1	39.3	34.3	37.5	36.4	33.9	38.0	35.1	37.5	36.6	40.0	43.3	39.0	38.0	88.9	37.0	22.5	29.4	
a BE	NOITARUG (SRUOH)	10.0	7.7	10.0	U,	0.03	19.7	0.12	0.003	17.1	18.8	21.8	0.21	24.6	48.0	0.05	18.9	0.1	1.0	
	(INCH) SC ^t	0.528	0.728	0.431	535		.356	İ	1.192	ı	0.800	0.840 21.8	ı	3.849	ა.600	,	0.600	784	.058	İ
	(HONI) U	0.155	0.188	0.1200.431	0.1420.535	:	0.330	1	313	1	0.212	0.237	l	0.242 0.849	0.176		0.184	0.2270.784	326	!
ESTING	^O MAX ^{IO} YIELD	0.91	0.91	0.91	0.91	0.60	0.57	0.60	0.58 0	0.74	0.74	0.78	0.82	0.76	0.85	0.90	0.85	0.460	0.51 0	:
TEST	OMAX (KSI)	60.0	0.09	0.09	0.09	39.6	37.5	39.6	38.5	48.6	48.7	51.4	54.1	50.1	56.4	59.5	56.4	30.1	33.6	
ST	ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR	LN2	AIR	AIR	AIR	LN ₂	LN ₂	AIR	AIR	AIR	AIR	AIR	LN ₂	
TEST PREP	(HOURS)	0.25	0.25	3.25	0.25	Ą	₹ Z	A A	Ą	Ą V	Z A	Š	A A	₹	Ą Z	Š	Š	۲ ۲	Š	ſ
KING	(× 1000) CACFER	A N	٨N	Ą	Ą Ą	2	D.	-	2	10	1.1	-	-	10	16	8	18	11	15	
PRECRACKING	ш	ΝA	۸N	A A	Ā	A A	Ą	۸A	Ą	A A	ΑN	Ą Ą	A	A N	NA	Š	Ą	A A	A N	
PREC	U (KSI)	A A	A A	Š	Š	15	15	25	15	15	15	32.5	32.5	15	15	15	15	15	20	i
(INCH)	2C,	0.528	0.570	0.430	0.531	1.196	1.192	1.358	1.192	0.804	0.785	0.814	0.849	0.848	0.599	0.545	0.574	0.784	1.053	
SIONS (a,	0.145	0.150	0.116	0.132	0.321	0.305	0.332	0.313	0.229	0.207	0.228	0.241	0.216	0.168	0.165	0.156	0.227	0.321	
MENS	_	7.0	7.0	7.0	7.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	
SPECIMEN DIMEN	3	5.006	5.002	5.004	5.003	6.00	00.9	00.9	00.9	00.9	00.9	00.9	00.9	6.00	00.9	9.00	9009	9.00	9.00	
SPECI	.	0.397	0.400	0.398	0.399	0.660	999.0	999.0	0.663	0.658	0.664	0.664	0.664	0.649	0.641	0.658	0.665	0.655	0.655	
	PROPAGATION NOITSERION	¥	¥	W	¥	¥	¥	¥	WT	₩	WT	WT	W	Ϋ́	¥	¥	Σ×	ΜŢ	ΙM	
	FORM	P	ľ	لے	ىھ	بے	ليم	ىے	ىي	ہے	J.	٦	ľ	J.	J.	ليم	ىي	ليه	لے	
()	THICKNESS (INCHOBIGINAL	1.0	1.0	1.0	1.0	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	
	SPECIMEN I.D.	A3A-5	A3A-6	A3A-12	A3A-25	AA -58	AA-49	AA-49	AA-52	CA-11	CA-38	CA-38	CA-38	CA-47	DA-17	DA-35	DA-31	AC-9	AC-9	
	ENVIRONMENT	r _{N2}																		

= LOAD / UNLOAD TES" = GROWTH WITH NO FAILURE = NO GROWTH

MAXIMUM GROWTH DID NOT OCCUR AT $\alpha = 0^\circ$

2> TESTED PREVIOUSLY

UNLOADED JUST PRIOR TO FAILURE, DELAMINATED

Table 35: Liquid Nitrogen Temperature (-320°F) Surface Flawed Sustained Load Tests of 2219-T87 Aluminum Alloy (Continued)

		REFERENCE	14	14	14	14	14	9	9	9	9	9	9	9	9	23	23	23	22	22
(200		COMMENTS	FAILURE 🔰 🔊	NF	FAILURE 2	NF	NG	NG	FAILURE	FAILURE	NG	FAILURE	FAILURE	FAILURE	FAILURE	FAILURE	NF	FAILURE	NF	NF
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		(k≳l <u>\ u`)</u> K [[]	-	34.7		29.1	27.9	42.9	48.2	48.5	51.0	59.7	58.3	60.4	58.6	_	43.6	_	40.7	41.4
<u>}</u>		(K2I <u>/ INT)</u> K ^{IL} (IBMIN)	1	33.1	,	27.9	26.5	40.8	45.6	46.3	48.6	56.4	55.1	57.2	55.7	_	40.9	-	38.3	38.8
	ွ	(K21 <u>/ IM)</u> K ^[]	43.1	34.1	40.7	29.1	27.9	42.9	44.2	45.6	51.0	53.6	1.32	56.5	989	42.7	41.6	41.4	40.5	41.2
	ESULTS	(KŞI <u>(M.)</u> K ^I (IBMIN)	41.6	32.5	38.7	27.8	26.5	40.8	42.1	43.3	48.6	50.9	51.5	53.6	55.7	40.2	39.2	39.0	38.1	38.7
לטווע וווחוווווווועוע	2	NOITARUD (SRUOH)	0.02	0.812120.032	p.2	0.750125.1 27	0.1	24.0	0.25	1.75	21.79	3.00	3.00	0.40	0.10	0.15	4.75	0.90	1.0	20.1
ì		(INCH) SC ^t		0.81	1	0.750	0.9121	ı	1.42	1.35	-	1.50	1.40	1.40		۲.	0.78	2	0.920	0.920
2		(INCH) " v	i	43.3 0.66 0.224	1	0.216	0.312	1	0.37	0.40	i	0.39	0.35	0.37	1	۸.	0.21	۷.	0.2480.920	0.71 0.267 0.920 20.1
Tarred Sustained Eodd Tests Of ££ 15-107	TESTING	U MAX ^{IO} YIELD	0.90	99.0	48.7 0.74	0.57	0.48	44.0 0.75	0.71	0.75	52.0 0.83	54.0 0.86	55.0 0.87	56.3 0.89 0.37	0.87	0.80	08.0	0.78	0.71	
3	TES.	^O MAX	59.5			37.9	32.0		45.5	46.2					57.4	54.5	54.0	53.0	47.0	47.0
100	TEST PREP	PRIOR ENVIRONMENT	LN2	AIR	LN ₂	AIR	LN ₂	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR
		SOAK TIME	Z Z	A A	Z A	AN	Z Z	Š	Ą Z	ΑN	Š	۷ ۷	ž	ž	Š Z	Z Y	A A	۸	<u>۷</u>	Z Z
200	PRECRACKING	(× 1000) CACLES	-	13	-	5	98	4~6	4~6	4~6	4~6	4~6	4~6	9~±	4~6	Z	Z	NA	NA	N A
	CRAC	<u>α</u>	Ą Z	Z	¥ Z	¥ .	8	۷ 2	Ž	Z	Ž Ž	Ž.	Ž	ş	Š	¥ Z	ž	Z A	2	Ž
	PRE((KSI)	37.6	15	32.5	15	20	25	52	25	52	25	23	22	22	22	8	82	12	12
/ Ourrace	IONS (INCH)	2C,	0.619	0.795	0.864	0.750	0.912	1.28	1.30	1.28	1.29	1.28	1.27	1.30	1.27	9.76	0.75	97.0	0.920	0.920
2	SIONS	ર્વે	0.191	0.212	0.238	0.213	0.312	0.30	0.29	0.31	0.29	0.30	0.29	0.30	0.30	0.19	0.18	0.19	0.242	0.261
	DIMENS	ب	8.0	8.0	8.0	8.0	8.0	=	=	11	=	=	Ξ	Ξ	=	=	=	Ξ	8.0	8.0
and.		3	9.00	6.00	6.00	9.00	6.00	0.9	0.9	6.0	6.0	6.0	6.0	6.0	6.0	9.00	9.00	5.99	9.00	6.00
ביליים יווי פשיי ופווישות ו	SPECIMEN	-	0.665	0.673	0.673	0.659	0.650	1.01	1.00	1.01	1.01	1.01	1.00	1.00	1.00	0.50	0.50	0.50	0.600	0.600
		PROPAGATION USECTION	WT	Ž	ξ	¥	¥	¥	¥	Μ	H.	Æ	₩ ₩	æ	4	F.	R	#	¥	¥Ι
		ноям	P	F	ىي	بے	F	نے	بے	ہ	ىي	بے	بح	ىھ	ىي	ىے	بے	ہے	ہے	P.
	(+	OBIGINAL THICKNESS (INCI	1.25	1.25	1.25	1.25	1.25	0.1	1.0	1.0	0.1	1.0	0.	0.	0.	0.5	0.5	0.5	0.1	1.0
		1.D. SPECIMEN	DA-31	CA-40	CA-40	CA 48	AC-7	SBT-24	SBT-21	SBT-22	SBL-26	SBL-27	SBL-16	SBL-15	SBL-14	BS3-1	BS3-2	BS3-3	н-3	1 4
		ENVIRONMENT	LN ₂ (CONT)																GH2	

= GROWTH WITH NO FAILURE = NO GROWTH 주 ਨ<u>~</u>

MAXIMUM GROWTH DID NOT OCCUR AT $\alpha = 0^{\circ}$

TESTED PREVIOUSLY

Table 35: Liquid Nitrogen Temperature (-320°F) Surface Flawed Sustained Load Tests of 2219-T87 Aluminum Alloy (Continued)

	REFERENCE	22	2	22	2	8	22	
	COMMENTS	T.	T.	N.	N.	NF	NF.	
	(k≳l <u>\ </u>	40.4	40.7	41.5	40.7	41.2	41.2	l
	(K2I <u>∕ IN')</u> K ^{IL} (IBMIN)	38.1	38.3	39.0	38.3		38.7	
١	(κει <u>λ ίνι΄)</u> κ ^[]	40.3	40.6	1.1	40.5	41.0 38.7	40.9	ľ
RESULTS	К: (K2I <u>\ IИ)</u> К ^{II} (IBMIИ)	38.0	38.2	38.7	38.2	38.5	38.4	ŀ
RES	(выпон)	8.0 3	10.1	10.0	10.1		10.0	ŀ
	(HONI) NOITARUO		20 16			125	120	
	SC [‡] (INCH)	0.710.2400.920	0.710.249 0.920	0.710.249 0.925	0.710.249 0.920	0.71 0.258 0.925 10.0	0.71 0.261 0.920	ŀ
-	,v	10.2	10.2	10.24	10.2	10.25	10.26	
TESTING	(KSI)					0.7	0.7	
TES	XAM ^O	47.0	47.0	47.0	47.0	47.0	47.0	
TEST PREP	PRIOR ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR	
	(HONBS) SOAK TIME	Š	ş	Š	۲ ۲	₹ Z	۲ ۷	
KING	(× 1000) CACFER	Ϋ́	Ą	4	A Z	4	A A	
RACI	Œ	ΝĄ	Ą Z	₹ Z	Ą	Š	ΑN	
PREC	U (KSI)	12	12	12	12	12	12	
IONS (INCH) PRECRACKING	2C,	0.920	0.920	0.925	0.920	0.925	0.252 0.920	
SIONS	a,	0.237	0.246	0.240	0.243	0.252	0.252	
MEN	ı.	8.0	8.0	8.0	8.0	8.0	8.0	
SPECIMEN DIMENS	3	6.00	6.00	5.97	6.ڏ	6.00	00.9	
SPECI	-	0.597	0.600	0.601	0.604	0.600	0.599	
	PROPAGATION NOITSELION	1W	¥.	ş	ž	ž	¥	
	FORM	R	P	ین	R	P	R	
(+	OHICKNESS (INCI	1.0	1.0	1.0	1.0	1.0	1.0	
	SPECIMEN 1.D.	FX-3	FX4	0F-2	0F-4	6-0	0.7	
	ENVIRONMENT	FLOX		0F2		r ₀ 2		

NF = GROWTH WITH NO FAILURE

-4130 F Temperature Surface Flawed Sustained Load Tests of 2219-T87 Aluminum Alloy Table 36:

	BEFERENCE	22	22	22
	COMMENTS	NF	NF	NG
	(k≳l <u>\ </u>	43.8	45.2	40.1
	(KSI ∧ I N')	11.3	42.4	37.6
	(KSI∧ IN')	3.6	5.2	0.1
RESULTS	κ ^ι ' (κ ટ ! <u>Λιν΄)</u> κ ^{ι'} (ΙΕΜΙΝ)	NA NA AIR 50.8 0.74 0.246 0.910 20.0 41.1 43.6 41.3 43.8	2.3 4	7.6 4
RES	(SAUOH)	0.0	0.0	0.
	(INCH)	20	35	0
	scł	0.9	0.0	6.0
	(INCH) ซ ^t	D.246	0.270	0.243
FESTING	U MAX ^{IU} YIELD	0.74	0.74	0.65
TES.	(KSI)	50.8	50.8	45.1
ST 1	PRIOR PRIVENT	AIR	AIR	AIR
TEST PREP	(HOURS)	Ą V	AN AN	A N
ING	(× 1000) CACFER	۷ 2	Ą	٨
RACK		٤	۸	۸A
PRECI	(KSI)	12	12	12
SPECIMEN DIMENSIONS (INCH) PRECRACKING	2C,	0.240 0.910 12 NA	0.268 0.935 12 NA NA NA AIR 50.8 0.74 0.270 0.935 10.0 42.3 45.2 45.2	0.243 0.970 12 NA NA AIR 45.1 0.65 0.243 0.970 1.0 37.6 40.1 37.6 40.1
NOIS	ર્ચ	0.240	0.268	0.243
MENS	ب	8.0	8.0	8.0
MEN D	>	6.00	00.9	6.00
SPECI	-	0.599	0.605 6.00	0.600
	PROPAGATION DIRECTION	WT	WT	Ψ
	MRO4	P.	ہے	ىي
(1	THICKNESS (INCHONICE)	0.1	1.0	0.1
	SPECIMEN	H-5	H-7	н-10
	TMAMMORIVNA	GH2		

NF # GROWTH WITH NO FAILURE NG # NO GROWTH

Table 37: Liquid Hydrogen Temperature (-423^o F) Surface Flawed Sustained Load Tests of 2219-T87 Aluminum Alloy

Г	BEFERENCE	2	2	2	2	2	14	14	14	14	14	14	14	22	22	22	
	COMMENTS	NF	NF	FAILURE	FAILURE 1>	±N.	NG 1	NF.	NF	NF	NG	NF	NF	NF	NF	-N	
\Box	(KSI \\ IM`) K ^I L	39.4	34.8		44.5	35.9	29.9	35.3	37.4	0 04	29.1	41.8	40 5 1	43.7	44.5	44.6	
	(K2I <u>/ IN')</u> K ^{IL} (IBMIN)	37.7	339	,	41.3	35.8	27.5	32.2	34.8	38 2	28.3	40.2	39.2	41.2	41.8	41.9	
٥	KRIN IN.)	38.9	34.6	88.4	41.3	35.6	29.9	34.9	37.0	39.6	29.1	40 5	40.1	43.6	44.2	4.	
RESULTS	(KŞI <u>(M)</u> K ^{II} (IBMIN)	37.3	33.8	36.9	39.3	35.5	27.5	31.9	34 4	37.9	28.3	39 1	38.9	41.1	41.6	41.7	
RES	NOITARUD (SRUOH)	r/n	۲/۵	4.3	2.2	10.0	12.4	10.9	10.3	6.6	10.8	11.8	44.0	ר/ח י	20.0	1.0	
	(INCH)	.443	370	~	0.540	0.377	1.66	228	1.123	767	0.564	808.0	0.601		940	925	
	(INCH)	0.120 0.443	0.260.0	~	0.164	0.102	808	0.48:0.3131	286	2190.767	0.157	0.271	0.199	0.2400.920	0.249.0	0.258 0.925	
S N	Q WAX 10 YIELD	0.91	0.910	16.0	0.910	0.910	0.420	0.48.0	0.54 0.286	0.69.0	0.610	0.69	0.780	0.740	0.740	0.740	
TESTING	(K2I) (MPX	65.0	65.0	98.0	68.0	65.0	30.9	35.3	39.7	50.9	44.6	50.9	57.2	9.09	50.8	50.8	
	PRIOR ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR 4	AIR	AIR	AIR	AIR :	AIR	
TEST PREP	(HOURS)	0.25	0.25	0.25	0.25	0.25	Š	Ą Z	NA	NA	Ą	٧V	Ą.	Ϋ́	NA	٨	
ONI	(× 1000) CACFE2	۷ Z	₹ Z	4 Z	ž	¥	¥	4	3	11	0t	12	8-	Š	A N	₹ Z	
RACK	Œ	Ą	Ş	۲ ک	₹ Z	Ą Ą	ž	₹ Z	A N	Ą	Ą	₹ Z	A A	Ą	Š	Ą	
PREC	U (KSI)	Ą	₹	ş	4	۲	15	15	15	15	15	15	15	12	12	12	
IONS (INCH) PRECRACKING	2C i	0.443	0.370	0.438	0.500	0.377	1.166	1.210	1.123	0.761	0.564	0.758	0.598	0.920	0.940	0.925	
	α,	0.113	ი:090	0.109	0.122	960.0	0.305	0.308	0.274	0.211	0.157	0.267	0.189	0.237	0.243	0.252	
MENS	7	0.4	4 0.	4.0	4.0	4.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	
SPECIMEN DIMENS	*	2.250	2.254	2.249	2.251	2.251	90.9	90.9	6.00	6.00	6.00	6.00	6.00	9.00	6.01	6.00	l
SPECII	ı	0.400	0.403	0.399	0.400	0.402	0.656	0.655	0.661	0.658	0.662	0.656	0.670	0.604	0.600	0.593	1
	PROPAGATION NOITSERION	ΙM	¥	ž	¥	¥	¥	Ļχ	ΙM	¥	ξ¥	¥	¥	¥	¥	£₩.	
	MAOR	نے	نے	نيم	ىي	ليم	لي	ىي	لين	ىي	لي	ہے	ہے	ىي	71	ہے	
L	DRIGINAL THICKNESS (INCI	0,	0.	0.	0.	0.	1.25	1.25	1.25	1.25	1.25	1.25	1.25	0.1	0.	0.	
	I'D' SEECIMEN	A2C-5	A2C-2X	A2C-4	A2C-17	A2C-1X	AA-21	AA-19	AA-61	CAN	DA-22	DA-20	DA-18	X:2	6- <u>H</u>	H 8	
	ти∋мионі∨и∋	LH ₂															

L/V = LOAD/UNLOAD TEST

NF = GROWTH WITH NO FAILURE

NG = NO GROWTH

1 FINAL FLAW SIZE ESTIMATED

Table 38: Room Temperature (70º F-75º F) Surface Flawed Sustained Load Tests of GTA Welded 2219-T87 Aluminum

		REFERENCE	8	Z	22	zz	z	72	22	22	22	z	22	zz	22	22	22	z	72	z	22
		COMMENTS	NF	ı.	NF	NF	NF	NF	Z.	N.	JF.	NF	NF	NF	NF	NF	N.	NF	NF	NF	NF
		(k≳i <u>/ </u>	•																		
		(K2I <u>∕ IN')</u> K ^I I (IBMIN)	24.2	23.9	24.3	24.1	24.3	24.2	23.0	24 1	218	24.0	24.1	23.9	24.2	24.1	24.2	19.3	24.1	24.1	24.3
	s	(KSI <u>) IN')</u> K ^{II}																			
No Post Weld Heat Treatment.	RESULTS	(K21 <u>\(IN')</u> K ^{II} (IUMIN)	23.9	23.7	23.8	23.9	24.1	24.0	122	23.8	21.6	23.8	23.8	23.6	23.5	23.8	23.9	19.2	23 9	23.8	24.1
reat	RES	NOITARUG (SRUOH)	ר/ח	16.0	23.9	14.6	13.4	14.9	3	15.8	ר/ח יַ	16.0	3.0	0	9.6		10.1	ר/ח	12.0	13.5	9.8
leat		(INCH) SC ^L	475	470	475	.465		480	475	475	465	460	1.465	450		4751	8	475	1.480	475	
pla H		(INCH)	0.4751	0.4401	0.4951	0.465 1.465	0.4751.500	1.09 0.4701	0.4571	0.4551	0.4471.465	0.463 1.460	0.465 1	0.4601.45010	0.470 1.475	0.465 1.475 10.0	0 4651	0.440 1.475	0.4551	0.4601	1.09 0.485 1.485
ost M	NG	α H O WAX ^{(O} YIELD	0 60	8	0 60	060	8	0.60	9	0.60	1.00 0.	8	1.09 0.	1.09 0.	1.09 10.	0	0 60.1	8	1.09 0.1	1.09 0.	<u>.0</u>
No P	TESTING	(KSI) QWPX	22.0 1	22.0 1	22.0 1	22.0 1.09	22.0 1	22.0 1	21.0 1	22.0 1	20.0	22.0 1	22.0 1.	22.0 1	22.0 1	22.0 1	22.0 1	18.0 0	22.0 1.	22.0 1.	22.0 1.
		ENVIRONMENT	AIR 2	AIR 2	AIR 2	AIR 2	AIR 2	AIR 2	AIR 2	AIR 2	AIR 2	AIR 2	AIR 2	AIR 2	AIR 2	AIR 2	AIR 2	AIR 18	AIR 2	AIR 2	AIR 2
No Filler Wire Used.	TEST PREP	SOAK TIME (HOURS) PRIOR	NA	ΥV	NA A	NA.	NA	A A	AN	NA A	A A	۹ ۷	A A	A A	₹ V	NA.	A A	NA A	NA	ν V	¥
ler M	ING	(× 1000) CACFE2	AN	AN	NA.	- eN	NA.	Ą.	AN P	NA.	A A	ح لا	A N	A N	A M	NA.	AN	NA	NA.	A N	- ₹
lo Fil	ACK	93.1272	AN	AN	NA.	A A	NA	¥.	A A	A A	٧	¥ X	A A	¥	A N	A N	A A	۲ ک	AN	A S	4
	RECF	U (KSI)	12	12	12	12	12	12	:3	12	12	12	12	12	12	12	12	12	12	12	12
Edge Preparation.	NSIONS (INCH) PRECRACKING	2C,	475	1.470	1.475	.465	.500	1.480	475	475	.465	1.460	1.465	.450	.475	475	480	475	.480	475	1.485
e Pret	NI) SN	α,	-	0.415 1	0.420 1.			0.440 1.	_	ı				_	_	_	75 1	-			
d Edg	NSIO	3	0 0.430	0 0.4	0 0.4	0.435	0 0.440	0.4	0 0.415	0 0.420	0 0.425	0.430	0.425	0.420	0.430	0.425	0 0.425	0.430	0.425	0.425	0.450
Welc		<u>.</u>	80	0 0	8.0	8.0	9.0	8.0	80	8.0	8.0	8.3	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Butt	MEN	≩	6.00	5.99	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.89	5.88
Square Butt Wel	SPECIMEN DIME		0.904	0.913	0.898	0.902	0.908	0.900	0.909	0.900	0.899	0.900	0.908	0.905	0.917	0.900	0.924	0.901	0.898	0.893	9060
Alloy.		MAOA	R	4	4	٦	4	ہے	٦	7	7	4	4	4	4	4	P.	4	4	4	4
₹	(+	OBIGINAL (INCI	1.0	1.0	1.0	0.1	1.0	1.0	1.0	1.0	1.0	0.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	<u>o</u> :
		I'D' SPECIMEN	WDP-1A	WAP-2	WS-1	WS-2	WH-1	E-HM	WDW-1	WDW-2	WDP-1	WDP-2	WFX-1	WFX-2	W0F-2	WOF-1	W0F-5	WT-1	WT-2	W0-1	W0-2
		ENVIRONMENT	AIR		3-1/2% NaCi		GH2		DISTILLED H		DYE PENETRANT		FLOX		OF ₂			TRICHLORO- ETHYLENE		602	

L/U = LOAD/UNLOAD TEST NF = GROWTH WITH NO FAILURE

Table 38: Room Temperature (70°F - 75°F Surface Flawed Sustained Load Tests of GTA Welded 2219-T87 Aluminum Alloy. Square Butt 'Yeld Edge Preparation. No Filler 'Vire Used. No Post Weld Heat Treatment (Continued)

	BEFERENCE	24	24	24	24	24	2
	COMMENTS	NF	NF	NF	NF	NF	NF
П	(KEL V IN.)						
	(KZI / IN') K ^I I (IBMIN)	34.2	35.2	36.2	33.1	37.3	36.4
ပ္	(k≳l ∕ <u>lin')</u> k ^{li}						
RESULTS	(KZI ∕ IN) K ! (IBMIN)	33.3	34.0	34.8	32.1	35.9	35.5
2	NOITARUD (SRUOH)	67.0				42.5	19,3
	(іисн) se ^t	970	.950 24.6	2.010	960	86	.950
	(INCH)	0.5201.970 67.0 33.3	.36 0.5301	.39 0.525 2.010 28.1	0.5301.960 24.0	0.550	0.5101.950 19.3
NG	WAX GYIELD	1.32	ı	1.39	1.28	1.43	1.41
TESTING	(KZI) QMAX	77.7	28.5	29.1	26.8	30.0	7.62
	ENVIRONMENT PRIOR	AIR	AIR	AIR	AIR	AIR	AIR
TEST	(HOURS)	₹	Ϋ́	ž	٨	4 Z	NA
ING	(× 1000) CACFER	2.7	2.8	3.6	1.8	2.0	2.0
4ACK	Œ	٤	ž	4 2	ž	₹ Z	٧Z
PRECI	(KSI)	0	10	9	02	01	10
NSIONS (INCH) PRECRACKING	2C.	1.960	1.950	1.960	1.960	1,960	1.950
SNO!	a,	0.460	0.445	0.450	0.450	0.450	0.450
MENS	7	9.0	9.0	9.0	0.6	0.6	9.0
SPECIMEN DIME	≩	6.00	909	600	8,00	6.00	6.00
SPECI	+	0.95	0.95	0.95	0.95	0.95	0.95
	МЯОЧ	-	يد	ہے	یے	نے	2
ĺН	THICKNESS (INC	1.0	0,1	1.0	0.	1.0	0.1
	SPECIMEN	SRW1-1	SRW1-2	SRW1-3	SRW1-4	SRW1-5	SRW1-6
	ENVIRONMENT	AIR (Cont'd) SRW1-1					

NF = GROWTH WITH NO FAILURE DOUBLE V WELD EDGE PREPARATION

o se de la companya del companya de la companya de la companya del companya de la companya del companya de la companya de la companya de la companya del companya de la companya del la companya del la companya del la companya del la companya del la companya del la companya del la companya del la companya del la companya del la companya del la companya del la compa

Liquid Nitrogen Temperature (-320°F) Surface Flawed Sustained Load Tests of GTA Welded 2219-T87 Aluminum Alloy, Square Butt Weld Edge Preparation. No Filler Wire Used. No Post Weld Heat Treatment Table 39:

	REFERENCE	23	23	23	23	22	22	z	z	\boldsymbol{z}	22	Z	22	z
	COMMENTS	NF	NF	ŊF	FAILED 🕥	NF	NF	FN	N.	NF.	T.	r.	NF	NF.
	(K\$I <u>\ </u>													
	(K2I <u>\ IN)</u> K ^I I (IBMIN)	27.0	26.1	6.62	-	7.12	8.72	27.3	23.6	23 6	23.7	23.5	27.5	27.3
ارا	(KSI <u>\ IN')</u> K ^{I'}												,,,	·
RESULTS	(K21 <u>\(IN)</u> K ¹ ! (IBMIN)	26.0	25.2	29.1	28.2	27.3	27.1	17.12	23.4	23.3	23.4	23.3	0.72	27.0
RES	NOITARUD (SRUOH)	46.2	20.0	8.6	0.17	0.9	10.0	ריט	8.0	11.3	9.9	10.0	10.0	2)
	(INCH) SC ^I	1.50	1.48	1.50	2	495	475	1.470	470	449 1.470	475	470	485	460
	(inch) α [†]	0.41	0.35	0.39	, ,	500	.536 1.	0.450	0.450	448	0.453	436	0.470	0.465
ING.	O MAX ^{IO} YIELD	0.98	0.98	1.10	1.08	0 10	1.01	1.01	0.89	0.89	0.89	0.89	1.0.1	10.1
TESTING	(KZI) (MAX	25.0	25.0 (27.8	27.5	25.0 1	25.0	25.0	22.0	22.0	22.0	22.0	25.0	25.0
F di	PRIOR ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	A IR	₹ E	AIR	AIR
TEST PREP	(HOURS)	٧V	NA.	AN	٨N	4	٧ ٧	AN A	Ą	۲ ۲	4	4	4	<u>لا</u>
CING	(× 1000) CACLES	٨	AM	Ą	A N	4	4	Ą.	٧ ٧	Š	٧ ٧	Ž	4	4
PRECRACKING	Œ	Ν	AN	4	¥ Z	Ą Z	4	A A	Α'n	Ą2	A Z	Υ Υ	₹	A N
PREC	U (KSI)	12	12	12	12	12	12	12	12	12	12	12	12	12
NSIONS (INCH)	<u>ح</u> ر ٰ	1.48	1.48	1.48	1.48	1.495	1.475	1.470	1.470	1.460	1.475	1.470	1.985	1.460
ONS	a,	0.34	0.30	0.35	0.32	0.430	0.425	0.425	0.425	0.420	0.423	0.415	0.410	0.430
	ا.	9	9	9	9	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
SPECIMEN DIME	3	6.01	6.01	6.01	6.01	5.99	5.90	5.90	5.97	5.90	5.90	2.90	5.90	5.90
SPECII	a a	66.0	0.97	76.0	66.0	0.915	0.905	0.897	0.910	0.895	906:0	0.838	0.895	0.903
	ноя	R.	4	7	H	æ	4	ہے	ہے	4	ہے	ہے	ہے	٦
(+	THICKNESS (INCHOBICINE)	1.0	1.0	1.0	1.0	0.	0.1	1.0	1.0	1.0	1.0	0.1	1.0	1.0
	SPECIMEN 1.D.	3W1-3	3W1-4	3W1-4	3W1-6	WAN-1	WH-5	WH-7	WFX-3	WFX4	WOF.4	WOF-6	WO-3	WS-1
	TNAMNORIVNE						GH ₂		FLOX		OF ₂		707	

L/U . LOAD/UNLOAD TEST

NF - GROWTH WITH NO FAILURE

TESTED PREVIOUSLY

Table 39: Liquid Nitrogen Temperature (-320°F) Surface Flawed Sustained Load Tests of GTA Welded 2219-T87 Aluminum Alloy. Square Butt Weld Edge Preparation. No Filler Wirs Used. No Post Weld Heat Treatment

	KEFERENCE	*	24	24	24	24	*
	COMMENTS	NF	NF	FAILURE	N	NF	NF
	KSI VINJ						
	(KEL A 1M)	35.2	38.1	_	36.9	39.4	37.6
	KSI VINJ						
PESULTS	(KZI/_INT) K ^{II} (IHMIN)	34.1	36.9	37.2	36.0	37.7	36.5
PES	NOITARUG (SRUOH)	23.5	24.0	0.12	29.0	15.2 37.7	-
	(INCH)	960	1,960	ı	980		096:
	(INCH)	0.5251	1.190.5101	1	-	.21 0.5801.950	1.07 0.52d 1.960 15.1
Σ	QMAX ^{IQ} YIELD	1.30	1.190	1.19	1.160.506	1.21	1.07
TESTING	(KSI)	28.5	31.0	31.0	30.1	31.5	30.5
Н	ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR
TEST PREP	(HOURS)	4	٧Z	٨N	٨	P:A	٧
<u>S</u>	(× 1000) CACEE	2	2	2.2	2	2	2
ACK	Œ	٧	¥	٩×	٨	٧×	٧
PRECRACKING	σ (KSI)	2	10	õ	10	10	10
NCH)	, S	1.960	1,955	1.950	1.960	1,950	1.960
SIONS (INCH)	a;	0.450	0.440	0.455	0.450	0,450	0.450
	٦	9.0	9.0	9.0	9.0	9.0	9.0
SPECIMAN DIME	3	6.00	6,00	6.00	6.00	6.00	6,00
SPECII	•	0.95	0.95	0.95	0.95	0.95	0.95
	МЯОЭ	2	ي	ہے	2	يے	•
()	THICKNESS (INCI	<u>.</u>	1.0	0.	6.	0.	1.0
	I'D'	SNW1-1	SWW1-3	SNW1-6	2-LANS	S-IMNS	SWW1-9
	TNEMNORIVNE	LN2 (Cont'd) SNW1-1					

NF = GROWTH WITH NO FAILURE
DOUBLE V WELD EDGE PREPARATION

-413⁰ F Temperature Surface Flawed Sustsined Load Tests of GTA Welded 2219-T87 Aluminum Alloy Square Butt Weld Edge Preparation. No Filler Wire Used. No Post Weld Heat Treatment Table 40:

	REFERENCE	22	2	z	2	8	
	COMMENTS	NF	NF	NF	Ą	FAILURE	
	(K2I <u>\ IM`)</u> K ^{I‡}						
	(KSI \ IN)	27.4	23.1	26.9	23.2		
s	K ^I (IBMIN) (KRIN IN) K ^I						
RESULTS	(KŞI <u>(IM)</u> K ^{II} (IBMIN)	26.9	22.9	26.5	23.1	28.2	
RES	NOITARUD (SRUOH)		10.0	اس-		0.05	
	(INCH) SC [‡]	.465	.480	.465	.480	,	
	(INCH)	4801	.420	462 1	.431		
NG	ם MAX ^{IO} YIELD	87 0	0 22.0	0 28.	77.0	.92	
TESTING	(K2I) QWAX	25.0 0.87 0.480 1.465 10.0	22.0 0.77 0.420 1.480 10.0 22.9	25.0 0.87 0.462 1.465 1	22.00.77 0.431 1.480 L/U	26.50.92	
	PRIOR ENVIRONMENT	AIR :	AIR	AIR	AIR	AIR	
TEST PREP	SOAK TIME (HOURS)	A N	A A	A N	A A	AN	
N.	(× 1000) CACFE2	۷ Z	4 2	٩	Q Z	A S	
3ACK	α	4 2	Ą Z	₹ Z	Š	A A	
RECE	υ (KSI)	1.2	12	12	12	12	
ONS (INCH) PRECRACKING	30	1.465	1.480	0.417 1.465	0.420 1.480	0.415 1.460	
	a,	0.410	0.400	0.417	0.420	0.415	
MEN	ب	8.0	8.0	8.0	8.0	8.0	
SPECIMEN DIMENS	3	₽.	5.88	5.90	5.90	5.89	
SPECI	-	0.89	0.913	0.909	0.900	0.903	
	мяоз	یے	균	4	بے	4	Ļ
(1	THICKNESS (INCH	0.5	1.0	0.1	0.	1.0	O TES
	I'D' SECIMEN	WH-8	WH-14	WH-10	W423-2	6-HM	CNLOA
	ENVIRONMENT	GH ₂					L/U = LOAD/UNLOAD TEST

L/U = LOAD/UNLOAD TEST
NF = GROWTH WITH NO FAILURE

Table 41: Liquid Hydrogen Temperature (-423^oF) Surface Flawed Sustained Load Tests of GTA Welded 2219-787 Aluminum Alloy Square Butt Wold Edge Preparation. No Filler Wire Used. No Post Weld Heat Treatment

	BEFERENCE	22	22
	COMMENTS	NF	T.
	(KSI\ <u>IN</u>) KIL		
	K	23.3	78.D
RESULTS	KI' (KRI AIN)	3.2	7.3
RES	DOITARUO (SRUOH)	2.3 2	1.1
	SC ^f	NA NA NA AIR 22.0 0.77 0.4531 475 12.3 23.2	0.425 1.480 12 NA NA NA AIR 25.6 0.89 0.495 1.490 11.1 27.3
	(INCH) Q [†]	0.453	0.495
TESTING	U MAX ^{/0} YIELD	77.0	0.89
TES	(KSI) (MAX	22.0	25.6
TEST ?REP.	PRIOR PRIOR	AIR	AIR
	(HONBS)	NA	A A
SNIS	(× 1000) CACFE	ΝA	٩
RAC	α	NA	AN
Phec	σ (KSI)	12	12
ISIONS (INCH) PRECRACKING		0.433 1.475 12	1.480
I) SNOI	a,	0.433	0.425
MENS		8.0	8.0
SPECIMEN DIMEN		5.90	5.90
SPECI	· •	3.902	0.921
	ьовм	P.	až.
(+	OBIGINAL THICKNESS (INCI	1.0	1.0
	I'D'	WH-11	WO-4
	ENVIRONMENT	LH ₂	

NF * CROWTH WITH NO FAILURE

Table 42: Room Temperature Air Surface Flawed Cyclic Flaw Growth Tests of 2219-T87 Aluminum Alloy. WT Propagation Direction

			1	_	_	_		10	100	<i>(</i> ^	/c	100	10	ر م		٦,,٦	7.		us.			l		7
<u> </u>	REFERENCE	2	2	4 5	2	2	3 5	56	56	56	56	56	56	56	26	26	56	56	26	36	92	76	92	4
	COMMENTS	(4, 5)		W/2c<4	(3)	(3)	₩2c<4(3	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	9	
	K ^I (Kai√In.)	53,9	54.0	32.1	46.3	50.0	27,3	7,7	6.7	9.9	7.1	14.0	9.6	14,5	17.9	20,8	3.6	3.7	10.7	6.4	6.3	9.5	13.5	١
	K _{II} (IBMIN) (Kai√In.)	1.4	44.3	27.7	41.4	42,5	25,0	6,4	5,9	5.8	6.1	12.2	8.5	12.4	15,7	17.9	3.2	3.3	9.0	5.8	5.7	8.4	11.9	
	K ^{[i} (Ksi√[n <u>·</u>)	25.1	30.7	24.5	26,6	29.7	24.4	7.2	6.4	6.4	6,3	12.9	9.1	13.0	16.7	18.5	3.6	3.7	9.4	6,3	6.1	9.0	12.4	7
RESULTS	K _{Ii} (IRWIN) (Ksi√ln.)	24.6	29.6	23.0	26.1	28.9	22.9	6.1	5.7	5.7	5.7	11.6	8.2	11,6	15.0	16.7	3.2	3.3	8.4	5.6	5.6	8,1	11.2	1
RES	NOITARUO (SəlɔyO)	1,685	926	4,351	1,012	617	4,000	4,000	4,000	4,000	2,000	1,000	3,000	1,500	200	200	0,250 10,000	40,000	3,000	5,000	5,000	3,000	1,500	
	Sc _f (Inch)	1.000	1,116	1,788	0,773	0.970	1,446	0,307	0.258	0.256	0,292	0.267	0.260	0.280	0.263	0.277	0,250	0.253	0.290	0.248	0.246	0,250	0.257	1
	s _f (Inch)	0.294	0.252	0.477	0.234	0.250	0,390 1,446	0,083	1,000	0,070	0.072	0.075	0.071	7,000	0.072	0.076	0.064	0,065	0.083	0.068	0.064	0.078	0.078	1
	MAX / Q YIELD	06.0			96'0				0.25	0.25	0.25	0.51	0.36	0.51	0.65	0.72 (0.14	0.14 (0.36	0.25	0.25 (0,36	0.50	1
ڻ ن	O _{MAX} (Ksi)	50.0	50.0	25.0	52.8	50.0	25.0	14.00	14,02	14,00	14.00	28.10	20.05	28.07	36.10	40.00	8.00	8.01	20.01	14.00	14.00	19.74	27.54	1
TESTING	PROFILE *	٧	٨	۷	٨	٧	٧	٧	٧	٧	٧	۷	۷	٨	4	A	٨	۷	4	٨	٧	V	4	1
1	ษ	0	0	0	0	U	0	0.0286	0.0286	0.0286	0.0286	0.0143	0.020	0,0143	0.011	0,010	0.10	0.10	0.020	0.0286	0.01	0.01	0.01	
	FREQUENCY (CPM)	20	20	20	20	20	20	60	9	60	60	8	8	8	9	9	8	120	120	120	8	8	8	1
- a.	ENVIRONMENT PRIOR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	(1)	(1)	(1)	(1)	Ξ	(1)	Ê	£	(1)	(1)	(1)	(i)	(E)	Ξ	1
TEST PREP	SOAK TIME	۸×	ΑN	ΑN	ΑN	NA	ΑN	٧V	ΑN	ΝA	٨	ΑN	ΝA	ΝA	ΝA	ΑN	ΝA	NA	ΝA	ΑN	ΑN	٧V	ž	1
ING	CACFE2 (×1,000)	A N	NA	ΑN	NA	ΝA	۸N	ΝA	ΝA	NA	NA	NA	NA	ΑN	ΑN	ΝA	ΝA	۸A	٧V	ΝA	٧V	٧V	٨	1
CRACKING	a	ΑN	ΑN	AN	ΑN	ΑN	ΑN	A	ΑN	ΑN	٧	ΑN	A	Ϋ́	ΑN	۸	ΑA	٧V	ΝA	AA	Ą	ΑN	٧ ک	1
PREC	Q (Kzi)	٧V	ΑN	۸N	ΑA	Ą	ΑN	20	20	20	20	20	8	20	20	8	8	20	20	20	70	20	8	1
SNO	Sc!	0.317	0.833	1,276	0.317	0,825	1,283	0,296	0,251	0.255	0.276	0,251	0.247	0,256	0,249	0,246	0,250	0,253	0.272	0.246	0.244	0.246	0,245	1
ENSIC	i ⁶	0.088 0.317	0.086	0.314 1.276	0.086 0.317	0.081 0.825	0,308	0.073 0,296	0.064 0.251	0.065 0.255	0.064 0.276	0.064 0.251	0.064 0.247	0.064 0.256	0.063 0.249	0.063 0.246	0.064 0.250	0.065 0.253	0.064 0.272	0.063 0.246	0.060 0.244	0.067 0.246	0.063 0.245	1
DIM Inch)	7	7.0	7.0	7.0	7.0	7.0	7.0	Ą	NA	۸N	ΑN	Ϋ́	Ϋ́	A A	Y Y	۲ ۲	Α	A	NA	NA	NA	ΑN	٨	1
SPECIMEN DIMENSIONS (Inch)	M	5.006	5.007	5,006	5.002	5.004	5,006	1.997	1.993	1.996	1.998	1.994	1.996	1,995	766.	1,998	1.998	1.993	1,995	966.1	2.009	2.012	98	1
SPEC	1		0.401			3.408		1.1252	1,1252	1253	1,1254	1250	1250	1251	1250	1251	1252	1252	1252	1252	1244	1259	1,1267	1
	новм	PLATE 0.402	PI.ATE	PLATE 0.798	PLATE 0.402	PLATE 0.408	PLATE 0.803	0,1252SHEET 0.1252 1.997	0.1252 SHEET0.1252 1.993	SHEETO.12531.996	SHI:ET0,1254 1.998	0.1250 SHI:ETO.12501.994	SHEET0.12501.996	SHI:ET0,1251 1.995	0.1251 SHEETO.12501.997	0.1251 SHEET 0.1251 1.998	0.1252 SHEETTO.12521.998	SHEET 0.1252 1.993	0.1252 SHE ET 0.1252 1.995	0.1252 SHEET 0.12521.996	PLATE 0.1244 2.009	PLA.TE 0.1259 2.012	PLA.TE 0,1267	1
	THICKNESS (Inch)	1.0	1.0	1.0	1.0	1.0	1.0	1.1252	1.1252	0.1253	0,1254	1.250	0,1250	0,1250	11251	1251	1252	0.1252	1,1252	1252	0.1		0:	7
	SPECIMEN IDENTIFICATION	A3A-18 1	A3A-19 1	A38-2	A3A-20	A3A-21 1	A38-3	1T 0	3T D	4T 0	7.7	9T 0	10T	11T 0	12T D	13T D	14T D	17T D	19T 0	20T D	1M	2M 1	3M	1

SEE FIGURE 13

10% NaOH ETCH

PRECRACKED IN BENDING CYCLED IN GASEOUS HELIUM

FINAL FLAW SIZE ESTIMATED E 8 8 € 6

CYCLED TO FAILURE

	REFERENCE	ဖ	ဖ	9	9	g	G	9	9	g	9	9	_Q	9	9	2 6	26	9	9	8	9	92	
	SEESONIVE	36	92	92	56	92	92	92	26	3) 26	3) 26	92	3 6	26	26	2	7	56	92	~	8	۲	-
	COMMENTS	2	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2, 3	(2, 3	(2)	(2)	(2)	(2)	(2)		(2)	(2)	(2)	2	(2)	
	K ^I I (Ksi√Iu•)	7,2	16.6	ı	6,3	8.3	16,8	17,3	19,4	١	-	16.1	16.0	10,4	5,1	23,6	22.2	15.7	15.9	22.2	16.3	23.0	
	K _I † (IBWIN) (Ksi√In.)	6.2	13.6	14.9	5.4	7,2	14,3	14,9	16,5	16.8	22.3	13.3	13.3	8,7	4.3	18.7	18.2	13,2	13.3	18.2	13.4	18.5	
	K (Ksi√In.)	6.7	14.0	15,6	5,6	7.7	14.8	15.6	17.7	15,1	20.1	14.4	14.5	9.4	4.7	19.4	19.5	14.4	14.4	19,5	14.6	19.6	
RESULTS	K ^{li} (IBMIN)	5.9	12.3	13.0	5,0	6.8	13,3	14.0	15.6	13,4	17.7	12.5	12.6	8,2	4.1	16.8	16.9	12,5	12,5	16.9	12,6	17.0	
RES	NOITARUO (Cycles)	10,000	2,000	2,000	15,000	5,000	1,000	750	200	3,770	1,420	1,500	1,500	5.000	40,000	1,000	1,000	1,500	1,500	1,000	1,500	1,000	
	Scf (Inch)	0,249	0.300	0.389	0.254	0,259	0,278	0,273	0,283	0.365	0.366	0.655	0.627	0.627	0.595	0,679	0,646	0.623	0.625	0.643	0,639	0.658	
	a _f (Inch)	0,080	0.087	0.106	0.085	080	0.085	0.079	9200	, E	a = t	0.145	0.143	0.143	0.143	0.167	0.151	0,144	0,145	0,153	0,149	0.160	
	™ ANELD	0.27	0,53	0.52	0.23	0.30	0.57	0,61	0.67	0.58	0.76	0.38	0.38	0,25	0.13	0.50	_		0.38	0.51	0.38	0.51	
U	(isX) XAM	14,66	29.28	28.63	12,53	16,63	31,67	33.54	36.77	31.86	41.87	20.83	21.18	13.88	6.97	27.84	28.03 0.51	20.91 0.38	21.01	27.96 (20.99 (28.05	
resting	PROFILE *	∀	۷	A	4	∢	∢	٨	٨	4	۷	٨	<	∢	٨	۷	۷	٨	∢	۷	٧	∢	
٢	ย	0.01	0.01	0,01	0.01	0.01	0.01	0.0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0,01	0.01	
	FREQUENCY (CPM)	8	8	8	3	8	8	8	99	8	8	8	8	8	120	9	8	9	9	240	240	9	
드	PRIOR ENVIRONMENT	(1)	Œ	Ξ	Ξ	Ξ	Ξ	Ξ	Ξ	Ξ	Ξ	Ξ	Ξ	Ξ	Ξ	Ξ	AIR	AIR	Ξ	Ξ	Ê	AIR	
TEST PREP	SOAK TIME (Hours)	٧A	٧V	٧	ž	ΑÑ	ΨN	¥N	A N	4 Z	Ą	A N	¥	Ϋ́	۷ ۷	٨	٨	¥	¥ Z	Š	۷ ۷	Ϋ́	
CING	CACFER (×1,000)	۷¥	٩	Α̈́	Ϋ́	ΨV	ΑN	ΑN	Ϋ́	Ą	Ą	Ā	¥.	¥	٨	ΑN	Ϋ́	ΑN	Ϋ́	٨	ΑN	ΑN	
CRACKING	ม	ΑN	Ą	٨	¥	٨	ΑN	۸	Ϋ́	δĀ	ΑN	Ϋ́	ΑN	Ϋ́	٨	٨	٨	٨	ΑN	₹	Ϋ́	ž	
PREC	Q (Ksi)	20	8	8	8	8	8	R	R	R	8	R	8	8	8	R	8	8	R	8	8	8	
	Sc!	0,245	0.270	0.318	0.240	0.249	0 257	0.250	c,263	0.263	0.257	0.637	0.603	0.613	0.589	0.599	0.599	0.593	0.595	0.596	609.0	0.596	
ENSIC	!e	0.064	0.063 0.270	0.074 0.318	0,063	0,065 0.249	0.065 0 257	0.065 0.250	0,065 0,263	0,065 0.263	0.063 0.257	0,120 0.637	0.121 0.603	0. 20 0.613	0,120 0.589	0.124 0.599	0,123 0,599	0,124 0,593	0.123	0,125 0,596	0.124 0.609	0.125	
DIM nch)	7	AN	¥	ž	Α V	¥	¥	¥	¥	ž	¥.	¥.	٨	¥.	¥	¥	¥.	۲.	٨	Y V	¥.	ž	1
SPECIMEN DIMENSIONS	W	2.002	2.002	2,001	2.001	2,001	2,008	2,015	2,010	2.001	2.002	3015	3008	3,018	3.014	3.018	+	3.012	3014	3,008	3.010	3,008	
SPEC	1	0.1193	<u>g</u>	11222	11197	1702	1258	1258	1218	1255	1193	,2385	1,2357	7,2388	2379	2380	2370	2362	2370	2378	.2374	.2370	1
	новм	PLATEO	PLATE 0.1194 2.002	PLATE 0,1222 2,001	PLATE 0,1197 2,001	PLATE 0,1702 2,001	PLATE 0,1258 2,008	PLATE 0,1258 2,015	PLATE 0,1218 2,010	PLATE 0,1255 2,001	PLATE 0,1193 2,002	0.2385 PLATE 0,2385 3,015	0.2357 PLA TE 0,2357 3,008	3.2388 PLATE 0,2388 3,019	3.2377 PLATE 0,2379 3.014	0.2380 PLATE 0.2380 3.018	0.2370 PLATE 0.2370 3.011	3.2382 PLATER, 2362 3.012	0.2370 PLATE 0.2370 3.014	PLATE 0,2378 3,008	0.2374 PLATE 0.2374 3.010	PLATE 1,2370	1
	THICKNESS (Inch)	1.0	9:		0.1	2:	0:-	2:	2:	2	2	.2385	,2357	.2388	2377	.2380	.2370	.2382	.2370	0.2378	,2374	0.2370	1
	SPECIMEN IDENTIFICATION	4W	SM	W9	7,0	8₩	М6	10M	11M	12M	14M	11		5T D	8T D	11T	12T	13T D		16Т	17.1	18T	

SEE FIGURE 13

^{10%} NaOH ETCH

CYCLED TO BREAKTHROUGH PRECRACKED IN BENDING 3 3 3

Table 42: Room Temperature Air Surtace Flawed Cyclic Flaw Growth Tests of 2219-T87 Aluminum Alloy. WT Propagation Direction (Continued)

	BELEBENCE	26	56	56	56	9	9	9	9	13	13	13	13	13	13	13	13	13	13		13	٦
	соммеитѕ	(2)	(2)	(2)	(2)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	₩2c<43	(3)	(3)	(3)	(3)	(3)	12c,<43	1
	K ^{I‡} (Ksi√In.)	15.7	10.6	10.9	10.9	51.7	42.0	52,6	41.8	43.2	44.5	-	33.9	39.8	34.1	40.1	38.8	44.5	33.8	37.7	33.7	
	K _I [(IBMIN) (Ksi√In <u>·</u>)	13.2	8.8	8.9	9.0	4.1.8	39.5	46,8	39.9	39.6	38.8	1	33,3	38.2	32.7	37.0	34.9	40.4	33.0	36.2	32.7	1
	K (Kai√In.)	14.3	9.6	9.5	9.7	35.5	38.1	37.7	40.1	27.2	32.0	34.7	26.4	31.5	25.0	27.4	29.5	34.4	26.1	31.6	24.8	1
RESULTS	K ^{Ii} (IBMIN) (Kai√In.)	12.5	8.3	8.3	8.4	33.7	36.2	35.8	38.0	26.7	30.5	33.1	26.0	30.9	24.6	26.6	28.1	32.8	25.7	31.0	24.3	1
RES	NORATION (Cycles)	1,500	2,000	5,000	5,000	510	83	208	17	645	139	1	1,109	367	1,787	3,060	1,694	361	4,052	1,438	7,443	
	Sc _f (Inch)	0.626	0.619	0.643	0,637	2,18	1,53	2.19	1,37	1.091	1,290	1	1,147	1,426	1.567	1,035	1,221	1,154	1.142	1.288	1.529	1
	a _f (Inch)	0,140	0.151	0.154	0.152	0.62	0.42	0,51	0.40	0.295	0,363	-	0.460	0.443	0.549	0.302	0.304	0.300	0.470	0.393	0.600	7
	QWAX / Q VIELD	0.38	0.25	0.25	0.25	0,65	0,69	0,70	0.72	0.78	17.0	0.78	0,62	0,64	0.53	0,75	0.67	0,78	0.62	0,64	0.53]
9	Q WAX (Ksi)	21.09	13.91	13.89	14.05	35.6	37.6	38.5	39.5	44.3	40,0	44.3	35,0	37.0	30.0	42.1	38.0	44.3	35,0	37.0	30.0	
TESTING	CACLIC LOADING	٧	٧	٨	٨	٨	٨	٨	٨	٥	a	۵	۵	a	O	٥	۵	a	a	a	٥	\rfloor
۴	ង	0.01	0.01	0.01	0.01	0	0	0	0	0	0	0	0	0	0	0.5	0.5	0.5	0,5	0,5	0.5	
	FREQUENCY (CPM)	09	38	9	9	1	-	-	-	-	-	-	•	ŀ	1	-	-	-	-	١	-	
TEST PREP	ENVIRONMENT	AIR	AIR	AIR	(1)	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	
HR	(Hours)	۸N	٨N	NA	NA	NA	NA	NA	NA	NA	٧V	ΑN	NA	٨N	٨N	NA	ΝA	٧V	NA	NA	NA	
SNIC	CACFE2 (×1,000)	AN	NA	NA	NA	4~6	4~6	4~6	4~6	4~20	420	4~20	420	4~20	4~20	4~20	4~20	4~20	4~20	4~20	4 ~20	1
CRACKING	ย	٨N	٨	ΑN	٨	90.0	90.0	90.0	90.0	NA	Ϋ́	ΑN	NA	٧	٨N	ΝA	٧Z	٩	٧V	ΑN	ΑN	7
PREC	Q (Ksi)	82	20	20	20	25	25	25	25	20~25	20-25	2025	20-25	20-25	20~25	20~25	20-25	2025	2025	20~25	2025	1
	Jc!	3.605	0.601	609.0	0.612	1.35	1.34	1.28	1.35	5.524		092.0	8.0 0,202 0,804 20~	1.007	8.0 0.254 0.976 20~	0.546 20~2	0.205 0.768 20-	0.201 0.751 20-	177.0	0.260 0.998 20~	0.923	7
OISN	!e	0.120 0.605	0,126 0,601	0.122 0.609	0.124 0.612	0.31	0.33	0.30	0.32	8.0 0.125 0.524	0.225 0.795	8.0 0.208 0.760	,202 (0.254	,254	0,151	3.205	1.201	0,203 0,771	3.260	0,262	1
g Gp Gp	7	AM	NA	NA		11	11	11	11	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	1
SPECIMEN DIMENSIONS	м	3,014		3.013	3.010	6.0	6.0	6.0	6.0	6.01	6.00	6.01	6.00	6,00	6.00	6.00	6.00	00.9	6.00	6.00	6.00	1
SPEC	1		.2385	,2389	,2365		1.01	1.01	1.01		_	_		1.239				-	1,239	_	1.240	1
	МЯОЭ	PLATE 0.2381	0.2385PLATE 0.2385 3.014	0.2389PLATE 0.2389	0.2364PLATE 0.2365 3.010 NA	PLATE 1.01	PLATE	PLA TE 1	PLATE 1	PLATE 0.608	PLATE 0.608	PLATE 0.612	PLATE 1.239	PLATE 1	PLATE 1.238	PLATE 0.609	PLATE 0.607	PLATE 0.607	PLATE 1	PLATE 1,242	PLATE 1	1
	THICKNESS (Inch)	0,2381P	.238EP	.2389P	.2365P	1.0 P	1.0 P	1.0 P	0°1	1.25 P	1.25 P	1.25 PI	1,25 P	1,25 P	1,25 P	1,25 P	1,25 p	1.25 P	1,25 P	1.25 P	1,25 P	
	SPECIMEN	21T 0	22T 0.	23T 0.	24T 0.	SBT-5 1.	SBT-4	SBT-6 1.	SBT-7	C0A6-1 1.	C0A6-2 1.	C0A6-3 1.	C0A12-1 1.	C0A12-2 1.	C0A12-3 1	C5A6-1 1		C5A6-3 1.	C5A12-1	C5A12-2 1	C5A12-3 1	

* SEE FIGURE 13

(1) 10% NaOH ETCH
(2) PRECRACKED IN BENDING
(3) CYCLED TO FAILURE

	REFERENCE	g	9	9	g.	9	g	9	9	9	9	5 6	9	5 6	3 6	92	92	5 6					7
	BEEEBENISE	26	26	56	92	92	92 () 26	92	92	92	7	56	2	7	2	2	7	9	3	3	3	\dashv
	COMMENTS	(2)	(2)	(2)	(2)	(2)	(2,3)	(2,3)	(2,3)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(4)	(3)	(3)	(3)	
	K ^I Ł (Ksi√ <u>In-)</u>	0.9	6.6	15.5	18.2	•	1		•	16.7	11.0	17.6	5,3	16.5	20.1	16.6	17.9	22.5	-	•	•	,	
	Klt (IRWIN) (Ksi√In.)	5.2	8.6	12.8	15.8	5.5	19.8	10.3	14.5	13.4	9.0	13,9	4.4	13.5	164	13.5	14,0	18,3		1	•	•	
	K ^{[i} (K²i∕ <u>lu'</u>)	5.5	0.6	13,4	16.6	5.5	18,2	0'6	13.1	13.7	9.7	14.1	4.8	14.7	17.6	14.7	14.2	20.02	45.4	17.86	20.02	21.95	
RESULTS	(Ksi√ln,) (Ksi√ln,)	4.9	8.1	11.8	14.9	4.9	15,7	8.1	11.7	12.0	8,4	12.3	4.1	12.6	15,3	12.6	12.4	17.2	43.2	15,11	13,37	16.81	
RES	NOITARUQ (cycles)	15,000	3,000	1500	200	142,000	2,103	18,065	5,272	3,000	2,000	3,000	40,000	15,00	1,000	1,500	3,000	750	089	370	106	241	
	Sc _f (Inch)	0,271	0.275	0.300	0,267	0.287	0.421	0.365	0,355	0.676	0.644	0,675	0.637	0.632	0,635	0.648	0.691	0.652	<u> </u>	,	٧	~	
	a _f (Inch)	0.083	0.076	0.089	0,078	0,109	a _n ≖t (a _n ≕t (a _Ω =t	0.180	0.158	0.177	0.157	0,153	0.154	0,154	0,184	0,154	2		1		1
	MAX / Q YIELD	0.22	0.36	0.50	0,65 (0.22	0,65	0.36	0.51	0.36	0.25	0.37	0.12	0.38	0.46	0.38	0.37	0.51	0.82	0.75	0.57	0,75	1
₀	O _{MAX} (Ksi)	11,85	19.78	27.63	35.78	11.87	35.62	19.77	27.97	19.76	13.87	20.64	6.81	21.06	25.40	20.91	20.46	28.03	45.7	42.0	32.0	42.0	
TESTING	PROFILE *	٧	٧	٧	٧	A	A	A	٨	A	٧	٨	A	A	٨	A	٧	٧	٨	۵	D	۵	1
TE	ย	10.0	0.01	1,0.0	0.01	0.01	0.01	10.0	00.0	0.0333	0.05	0,0333	0.10	0.01	10.0	0.01	0.0333	0.010	0.0	0.1	0.1	0.1	
	FREQUENCY (CPM)	99	09	09	9			9		9	9	09	120	9	90	09	9	09	1	20	20	8	1
۳.	ENVIRONMENT	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	Œ	(1)	(1)	(1)	(1)	AIR	AIR	(1)	AIR	AIR	AIR	AIR	7
TEST PREP	SOAK TIME (Hours)	ΝA	NA	ΑN	٧	ΑN	ΑN	AN	٨	Ą	NA	٧V	NA	ΑN	Y Z	٧	NA.	AN	NA.	٧V	NA	¥ Z	1
ING	CACLES (×1,000)	٨A	NA	ΑN	ΑN	ΑN	NA	NA	NA	ΑN	NA	ΝA	NA	NA	NA	ΝA	ΝA	NA A	9~	٧A	NA	Ϋ́	1
CRACKING	R	AN	NA	ΑN	A N	AA	NA N	A	A	AN	AN	NA	AN	٨	ΑN	۸A	٨A	۲N	0.06 4	ΑA	۸A	Ϋ́	1
PRECR	Q (Kai)	20	20	20	20	20	20	20	20	20	20	20	20	82	50		20	20	22 (9	≤16 ₽	9	1
	Sc!	,257	1.261	272.0	3.249	,256	3,286	3,248	.253	.617	909.	0.601	.622	.599	.593	909.	.597	.611	1.27	,553	,822	9.800	7
OISNE	g!	0.067 0.257	0.062 0.261	0,068 0.272	0.0640.249	0,066 0,256	0.071 0.286	0.066 0.248	0,067 0,253	0,127 0.617	0.128 0.608	0.123	0.128 0.622	0.125 0.599	0.124 0.593	0,126 0.608	0.128 0.597	0.128 0.611	0.30	0.031 0.553	0.044 0.822	0.038 0.800	1
N DIME	٦	NA.	NA	NA	NA	NA	NA	NA	NA	¥.	NAI	NA	NA C	NA	NA	NA	N'A C	NA	11) 01	10	10	┪
SPECIMEN DIMENSIONS (Inch)	M	2.019	2.013	2.016	2.011	2.011	2.015		2.010	3.040	3.045	3,015	3.036	3.034	3.026	3.030	3.019	3,026	6.0	6.75	6.75	6.75	1
SPEC	1						0.1254	.1259 ;	1295									_	_		0.062	1	7
	ЕОВМ	SHEET 0.1256	SHEET 0.1256	SHEET 0.1257	0.1251 SHEET 0.1251	0.1257 SHEET 0.1257	SHEETO	0.1259 SHEET 0.1259 2.009	0.1245SHEET 0.1295	PLATE 0.250	PLATE 0.237	PLATE 0,241	0,242 PLATE 0,242	0.235 PLATE 0.235	0,235 PLATE 0,235	0,237 PLATE 0,237	0,243 PLATE 0,243	0,236 PLATE 0,236	PLATE 1.00	40.125 SHEET 0.067		0.125 SHEET 0.066	7
-	THICKNESS (Inch)	0.1256	0,1256	0,1257	1251	1257	0.1254 SHEET	1,1259	.1245	0.250	0.237	0.241	0.242	0,235	0.235	0,237	0,243	0.236	1.0	0.125	0.125 SHEET	0.125	1
	SPECIMEN IDENTIFICATION	1. p	2L p	3L D	41. 0	5L D	8L	9F 0	10L 0	31	15L 0	21L 0	22L	24L ·	25L	79F	27L	28L	SBL-3	ABC 30R-14	ABC 39R-3	ABC 39R-2	

SEE FIGURE 13 10% Na OH ETCH

PRECRACKED IN BENDING E 8 8 3

CYCLED TO BREAKTHROUGH DELAMINATION, CYCLED TO FAILURE

Table 43: Room Temperature Surface Flawed Cyclic Flaw Growth Tests of 2219-T87 Aluminum Alloy, RT Prupagation Direction (Continued)

_		-	_	,	_	_	_		_	,
<u> </u>	BELEBENCE	3	3	3	3	3	3	3		
	соммеитѕ	(1)	(1)	(2)	(2)	(2)	(2)	(2)		
	K _{IŤ} (Ksi√In.)	1	1	1	1	1				
	K ^{I‡} (IBMIN)	_	I	I	-					
	K ^{II} (K₂i√ <u>In.</u>)	30,87	29,25	24,63	23,94	32.45	28.36	31.11		
RESULTS	K ^{II} (IBMIN) (Ksi√In.)	22.64 30.87	18.50	24.16 24,63	23,30	31.44	27.49	27.95		
RES	DURATION (Cycles)	22	8	2927	3909	1013	2737	798		
	Sc _f (Inch)	¿	۲.	7	į	2	7	٧		
	(lnch) _† 8	1	ţ	į	7	۷	7	7		
	Q MAX \ Q YIELD	0.93	0.75	0.64	0.55	0,73	0.64	0,64		
ပ္	Q WYX (Kei)	52.0	42.0	36.0	31,0	41.0	36.0	36.0		
TESTING	PROFILE *	a	a	a	a	a	a	۵		
1	ย	0.1	0.1	0.1	1.0	0.1	0.1	0,1		
	FREQUENCY (CPM)	20	20	50	07	20	20	8		
ST EP	ENVIRONMENT PRIOR	AIR	AIR	AIR	AIR	AIR	AIR	AIR		
TEST PREP	(Honiz)	٨N	۸N	۸N	ΑN	ΑN	NA	۸		
CRACKING	CACFE2 (×1,000)	۷N	ΝA	ΝA	۷V	۸N	ΝA	ΑN		
RAC	ย	ΝA	NA	NA	NA	ΝA	NA	NA		
PREC	Ø (Ksi)	< 16		≤ 16	≥ 16		< 16			
	ʒc!	0.800	0.967	_				0.875		
ENSIC	·e	0.042	0.046	0.230 0.569	0.286 0.724	0.278 0.740	0.282 0.743	0,350		
DIM Inch)	7	01	10	10	10	10	10	10		
SPECIMEN DIMENSIONS (Inch)	M	6.76	6.75	6.74	6.74	6.74	6.74	6,74		
SPE(1	0.068	0.061	0.645	0.627	0.638	0.636	0.643		
	ноям	SHEET	SHEET	PLATE	PLATE 0.627	PLATE 0.638	PLATE	PLATE		13
	THICKNESS (Inch)	0,125				0.625	0.625	0.625		GLIRE
	SPECIMEN	ABC 39R-4 0	ABC 48R-5 0.125	ABC 25R-1 0.625	ABC 31R-2 0,625	ABC 318-3 0	ABC 31R-40	ABC 38R-5 0		* CFF FIGURE 13

SEE FIGURE 13

CYCLED TO BREAKTHROUGH CYCLED TO FAILURE - Marie Communication Commun

Table 44: Room Temperature Surface Flawed Cyclic Flaw Growth Tests of 2219-T87 Aluminum Alloy in Salt Water, WT Propagation Direction

	иеневеисе В в в в в в в в в в в в в в в в в в в в	2	5	2	2	5	5	5	5	5	2	5	
	COMMENTS			W2c<4						(2,3,4)			
	K ^I Ł (K²i√ <u>In.</u>)	49.5	47.1	30.0	54.0	31.5	28,5	41.7	33.3	61.2	31.5	30.3	
	K _I ∱ (IRWIN) (Ksi√In.)	42.1	8.04	26.6	44.3	30.3	27.5	37.9	31.6	47.3	30.2	29.5	ľ
:	K ^{[i} (Ksi√In.)	25,3	31,3	24.5	33.8	29.2	27,0	36.1	33.1	33.9	29.0	28.2	
RESULTS	(Ksi√ln,) K _{li} (IRWIN)	24.8	30,0	23.0	32.1	28.1	26.2	8,0	31.4	32.4	28.0	27.4	
RES	NOITARUO (Cycles)	1595	396	3430	729	184	499	155	94	402	573	493	
	Sc _f (Inch)	0.925	0.920	1,625	1,050	0,462		0,755	0,535	1,235	0,464	0,403	
	a _f (Inch)	0,260	0.222	0.449	0,273	0,145	0.116	0.206	0.139	0,298	0.141	0.120	
	MAX / Q YIELD	0.90	06'0	0.45	06.0	06.0	0.90	06.0	06.0	0.90	0.00	0.93	
၅	Ø _{MAX} (Ksi)	50.0	20,0	25.0	50,0	50,0	50.0	50,0	50,0	50.0	50.0	51.8	
TESTING	PROFILE *	۷	٨	٧	8	8	В	၁	၁	၁	၁	ပ	
TE	ย	0	0	0	0	0	0	0	0	0	0	0	
	ЕВЕФПЕИСА (СЬW)	20	20	8	0,5	0.5	0.5	0.2	0.2	0.2	0.2	0,2	
ST EP	ENVIRONMENT ENVIRONMENT	AIR	(1)	AIR	AIR	AIR							
TEST PREP	(Hours)	٧V	NA	NA	NA	NA	NA.	NA	NA	NA	NA	Ϋ́	
ING	CACFES (×1,000)	ΝA	ΝA	۸A	ΑĀ	NA	NA	NA	NA	NA	NA	ΝΑ	
CRACKING	A	NA	٧	Ą	Ą	Ą	Ą	Ą	٧	Ą	ΝA	Ą	
PREC	(is)' O	NA	NA	ΑN	ΑN	Ā	ΑN	٨	ΑN	A	NA	ΑN	
SNC	Sc.	0.2	J.815	1.278	0.542	0,413	0.366	0.620	0.535	0.538	0.412	0.367	
ENSI	ļe ļ	0.091 0.7	0.090815	7.0 0.313 1.278	0,148 0.542	7.0 0,115 0,413	0,097 0.366	0,161 0,620	0,135 0.535	0.158 0.538	0.112 0.412	0.098 0.367	
N DIN	٦	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	
SPECIMEN DIMENSIONS (Inch)	W	5,006	5,006	5,005	5.005	5.004	5.062	5.004	5.005	5.005	5.008	5.000	
SPEC	1	0,406	0.399	0.801	0.405	0.405	0.403	2406	2404	2404	2,403	3406	
	FORM	PLATE 0,406 5,006	PLATE 0,399 5,006	PLATE 0.801 5.005	PLATE 0.405 5.305	PLATE 0.405 5.004	PLATE 0.403 5.062	PLATE 0.406 5.004	PLATE 0.404 5.005	PLATE 0.404 5.005	PLATE 0,403 5,008	PLATE 0.406 5.000	_
	ORIGINAL THICKNESS (Inch)	1.0	0,	Ĉ.	0:	1.0	0:	01	1.0	0.1	0.	0.0	
	SPECIMEN IDENTIFICATION	A3A~22	A3A-23	A38-4	A3A-34	A3A-35	A3A-37	A3A-31	A3A-33	A3A-33	A3A-36	A3A-38	

SEE FIGURE 13

PREVIOUSLY TESTED 31/9% NaCI AND AIR E 0 0 3

FINAL FLAW SIZE ESTIMATED

CYCLED TO FAILURE

	adhana an																		Γ.				-
<u> </u>	REFERENCE	12	2	2	1 2	1] 2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	_
	COMMENTS	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)		(1,2)		(1)		(1,2)			(1,2)		(1,2)		(1,2)	
	K ^{Iţ} (Ksi√ <u>In.</u>)	•		ı	•	•	,	,	,	7.72	•	24.5	•	30.4	-	30,2	29,2	•	31,8	,	27.3	,	
	(K²i√ <u>Iu.)</u> K ^I [(IBWIN)		-	•	•	-	•	•	-	25.9	35,4	23.8	33,4	27.9	36, U	27.7	26.9		28,9	•	26.7		
	K ^{[!} (K≈i∕ <u>Iu'</u>)	20.8	20.9	18.6	18.4	18.5	24.4	22.4	20.7	24.3	28.7	23.5	24.9	29.6	30.8	29.9	28.2	30.6	30.8	33.5	26.2	28.1	
RESULTS	K ^{II} (IRWIN) (Ksi√In.)	19.2	19.5	17,5	17,6	17,4	21,3	20,4	19,0	23.4	26.6	22.8	24.1	27.4	28.3	27.7	26.1	27.9	28.1	30.0	25.7	27.4	
RESI	NOITARION (Cycles)	2490	1818	2026	3180	2768	1072	2021	2150	300	929	200	1030	15	255	10	7	93	2	88	186	720	
	Sc _f (Inch)	0.400	0.390	0,350	0.390	0.600	0.610	0.520	0.530	0,231	0.430	0.190	0,393	0.264	0.450	0.270	0.530	٤	.555	~	0,240	0.450	
	a _f (Inch)	a≖t	a≖t	a≖t	a≖t	8*t	a≖t	a=t	a≖t	0.081	a≖t	080'0	0,135	0,102	a≖t	0,104	0.048	a=t	.057	1=0	0.102	1=8	
	™ ANELD	0,67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	06'0	06.0	06'0	06.0	0.90	_	0.30	06'0	06'0	06.0	06'0	06.0	06.0	
ى ق	O _{MAX} (Ksi)	43.8	43.8	43.8	43.8	43.8	43,8	43.8	43.8	59.8	59,8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	
TESTING	CACLIC LOADING	۷	٨	∢	٨	V	⋖	4	٧	4	٨	٨	٨	4	4	4	٨	٧	4	۷	∢	4	
TE	ម	0	0	٥	0	٥	٥	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	РРЕQUENCY (СРМ)	8	8	8	8	R	8	8	8	ଷ	8	8	ଷ	8	8	8	8	20	8	8	8	8	
T. G	ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	N. P.	AIR	3	AIR	1	AIR	AIR	NH/A	AIR	A PER	AIR	No.	
TEST PREP	SOAK TIME (Hours)	٧	٧	Y Y	¥.	Y Z	¥.	Y Y	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
SNI	CACFE2 (×1,000)	٩	Ą	A A	۷ ۷	Ϋ́	A	Ą	Ν	A N	ΑN	A N	A	٨	NA	Y Y	NA	NA	NA	Ϋ́	ΑN	٧	
CRACKING	ย	ΑĀ	Ϋ́	Ϋ́	¥	¥	ΑN	ΑN	٨	Ą	Ą	٨	٧	٧	Ą	۷ Z	NA	AA	ΑN	٤	¥	Ϋ́	
PRECI	Q (Ksi)	ΑĀ	Y Y	٨	₹ Z	¥	¥	¥	15	15	8	15	8	12	18	12	15	18	15	8	5	8	
	Sc!	c,250	ر ارت	ر رو	0,205	0,530	0.540	0,450	0,460	0.186	0.243	0.176	0.195	0,255	0.270	0,261	0,530	0.530	0.555	0.555	0.222	0.252	
OISNE	ļ _e	0.085	0.100	0,075	0.077	0.040	0.065	0.062	0.051	0.071	0.085 0.243	0.068	0.082 0.195	0.098	0.105	0.100 0.261	0.045	0.053	0.053 0.555	0.063		0.108	
DIM!	ן	9	9	9	9	7	7	7	7	9	9	9	٥	9	9	9	7	7 [0	7 0	7	ဖ	9	1
SPECIMEN DIMENSIONS (Inch)	W	3.50	3.50	3.50	3.50	5.00	5.00	2.8	2,00	3,49	3,49	3.49	3.49	350	3.50	3.50	5.00	5.00	5.00	2.00	3.50	3.50	1
SPEC	1	0.152	0.149	0,140	0.151	0.154	0.143		0.150	0.150	0.150	0.149	_	0.151	0.151	_	0.150	0,150	0.152	0.152	0.203	0.203	1
	новм	PLATE	PLATE	PLATE 0.140	1.00 PLATE 0.151	PLATE	PLATE 0.143	PLATE 0.154	PLATE	PLATE 0.150	PLATE	PLATE	PLATE 0.149	PLATE	PLATE	PLATE 0.155	PLATE	PLATE	PLATE	PLATE	PLATE	PLATE	
	THICKNESS (Inch)	1.00	8.	8.	8.	8.	9.	8	8.	6.	6.	0.	9:	2	9:	2	5.5	<u>0:</u>	0.1	2:	0.	2	
	SPECIMEN	0A14-1	0SA14-2	0A14-5	0A14-6	0A11-1	0A11-2	0A11-5	0A11-6	CA14-1	CA14-1	CA14-2	CA14-2	CA14-3	CA14-3	CA14-4	CA11-1	CA11-1	CA11-2	CA11-2	CA24-1	CA24-1	

SEE FIGURE 13

PREVIOUSLY TESTED CYCLED TO BREAKTHROUGH 2 3

Table 45: -37% F Surface Flawed Cyclic Flaw Growth Tests of 2219-T87 Aluminum Alloy, WT Propagation Direction (Thickness <0.25 in) (Continued)

SPECIMEN DIMENSIONS PRECRACKING TREFT TESTING SPECIMEN DIMENSIONS PRECRACKING PREPT TESTING														
SPECIMEN DIMENSIONS PRECRACKING PREST TESTING PREST		BEFERENCE	2	2	2	2	2	2	2	2	2	2	2	
SPECIMEN DIMENSIONS PRECRACKING PREPRING PREPRING PREPRING PRECRACKING PREPRING PRE		COMMENTS		(1,2)		(1,2)		(1,3)	(1,2)		ε		ε	
SPECIMEN DIMENSIONS PRECRACKING TEST TESTING PRECRACKING TESTING		K ^{IŁ} (K²i√ <u>In')</u>	27,8	•	31,3	•	31,4		53.7	28.2	•	30.6	47.6	
SPECIMEN DIMENSIONS PRECRACKING PREPT TESTING TE			27.0	,	29.6	40,5	30,0	•	41.4	27.2	,	28.7	:18,5	
SPECIMEN DIMENSIONS PRECRACKING PRECRA			26.3	28.2	30,3	37.7	29,9	32,1	37.8	26.0	28.5	26.6	31.7	
SPECIMEN DIMENSIONS PRECRACKING TEST TESTING (Inch) 1.0 PLATE 0.205 3.50 6 0.100 0.285 AIR 20 0 A 59.8 0.90 0.114 0.207 1.0 PLATE 0.205 3.50 6 0.100 0.285 AIR 20 0 A 59.8 0.90 0.114 0.207 1.0 PLATE 0.205 3.50 6 0.100 0.285 AIR 20 0 A 59.8 0.90 0.114 0.207 1.0 PLATE 0.205 3.50 6 0.100 0.285 AIR 20 0 A 59.8 0.90 0.114 0.207 1.0 PLATE 0.205 3.50 6 0.100 0.285 AIR 20 0 A 59.8 0.90 0.114 0.207 1.0 PLATE 0.205 3.50 6 0.100 0.285 AIR 20 0 A 59.8 0.90 0.114 0.207 1.0 PLATE 0.205 3.50 6 0.100 0.285 AIR 20 0 A 59.8 0.90 0.114 0.207 1.0 PLATE 0.205 3.50 6 0.100 0.285 AIR 20 0 A 59.8 0.90 0.114 0.207 1.0 PLATE 0.205 3.50 6 0.100 0.285 AIR 20 0 A 59.8 0.90 0.114 0.207 1.0 PLATE 0.205 3.50 6 0.100 0.285 AIR 20 0 A 59.8 0.90 0.114 0.207 1.0 PLATE 0.205 3.50 6 0.100 0.285 AIR 20 0 A 59.8 0.90 0.113 0.207 1.1 0.303 1.0 PLATE 0.205 3.50 6 0.100 0.285 AIR 20 0 A 59.8 0.90 0.114 0.207 1.1 0.303 1.1 0.303 1.1 0.207 1.1 0.303 1.1 0.207 1.1 0.303 1.1 0.207 1.1 0.303 1.1 0.207 1.1 0.303 1.1 0.207 1.1 0.303 1.1 0.207 1.1 0.303 1.1 0.207 1.1 0.303 1.1 0.207 1.1 0.303 1.1 0.207 1.1 0.303 1.1 0.207 1.1 0.303 1.1 0.207 1.1 0.303 1.1 0.207 1.1 0.303 1.1 0.207 1.1 0.207 1.1 0.303 1.1 0.207 1.1 0.2	ULTS		25.6	27.3	28,9	30,2	28,7			25,3	27.5	25.7	29.5	
SPECIMEN DIMENSIONS PRECRACKING PREP TEST TESTING (Inch) OFITICIONAL SS CONTROLLES THE CONTROLL	RES	(Cycles)	250	757	20	240	85	362	25	131	478	153	592	
SPECIMEN DIMENSIONS PRECRACKING TEST TESTING LICHARD SINGLESS LI		Scf (Inch)		0.59	0,297	0,57			0,790		7		0.600	
SPECIMEN DIMENSIONS PRECRACKING TEST TESTING LICOLOGY		s _f (Inch)	0.100	a≡t	0.114	0.19	0.121	æ≓t	0,135		7	0,056	0,130	
SPECIMEN DIMENSIONS PRECRACKING PRECRA		™ WAX \ Q YIELD	06.0	06.0	06.0	06.0	06.0	06.0	06,0	0.90	06'0	0.00	0.90	
SPECIMEN DIMENSIONS PRECRACKING TEST		Q _{MAX} (Ksi)	8.65	59.8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	
SPECIMEN DIMENSIONS PRECRACKING TEST	STIN		٧	∢	∢	∢	4	4	∢	٧	٨	٧	٧	
SPECIMEN DIMENSIONS PRECRACKING TEST (Inch) SPECIMEN DIMENSIONS PRECRACKING PREP (Inch) SECTION OF THE CLOOK STATE CLOOK STA	TE	ង	0	٥	0	٥	0	0	٥	0	0	0	٥	l
SPECIMEN DIMENSIONS PRECRACKING PRE [Inch] SPECIMEN DIMENSIONS PRECRACKING PRE [Inch] SPECIMEN DIMENSIONS PRECRACKING PRE [Inch] SPECIMEN DIMENSIONS PRECRACKING PRE [Inch] SPECIMEN DIMENSIONS SPECIMEN DIMENSIONS SPECIMEN DIMENSIONS SPECIMEN DIMENSIONS SPECIMEN DIMENSIONS SPECIMEN SPART SPECIMEN SPECIMEN SPECIMEN SPECIMEN SPECIMEN SPECIMEN SPECIME		ЕВЕОПЕИС А (СЬМ)				8	8	8	8	8	8		1 1	
SPECIMEN DIMENSIONS PRECRACKING PRE [Inch] SPECIMEN DIMENSIONS PRECRACKING PRE [Inch] SPECIMEN DIMENSIONS PRECRACKING PRE [Inch] SPECIMEN DIMENSIONS PRECRACKING PRE [Inch] SPECIMEN DIMENSIONS SPECIMEN DIMENSIONS SPECIMEN DIMENSIONS SPECIMEN DIMENSIONS SPECIMEN DIMENSIONS SPECIMEN SPART SPECIMEN SPECIMEN SPECIMEN SPECIMEN SPECIMEN SPECIMEN SPECIME	Feli		AIR	7	AIR	114	AIR	建	AIR	AIR	1442	AIR	1	ĺ
SPECIMEN DIMENSIONS PRECRACKING [Inch] SPECIMEN DIMENSIONS PRECRACKING [Inch] LS SPECIMEN DIMENSIONS PRECRACKING SEC SEC SEC SEC SEC SEC SEC SEC SEC SEC	TES	(snuoH)	25				0.25			0.25				
SPECIMEN DIMENSIONS PRE (Inch) LO PLATE 0.202 3.50 6 0.088 0.222 15 1.0 PLATE 0.197 3.50 6 0.102 0.262 20 1.0 PLATE 0.197 3.50 6 0.102 0.203 20 1.0 PLATE 0.197 3.50 6 0.102 0.203 20 1.0 PLATE 0.204 3.50 6 0.102 0.203 20 1.0 PLATE 0.204 3.50 6 0.102 0.203 20 1.0 PLATE 0.204 3.50 6 0.102 0.203 20 1.0 PLATE 0.204 3.50 6 0.104 0.203 20 1.0 PLATE 0.204 3.50 6 0.104 0.203 20 1.0 PLATE 0.204 3.50 6 0.042 0.203 20 1.0 PLATE 0.204 3.50 6 0.042 0.203 0.203 1.0 PLATE 0.204 3.50 6 0.042 0.555 1.5 1.0 PLATE 0.204 4.00 6 0.042 0.555 20 1.0 PLATE 0.204 4.00 6 0.060 0.555 20	SNIX	CACLES (×1,000)	ΑN	$\overline{}$	_	T .	Ī	Γ	Γ					
SPECIMEN DIMENSIONS PRE (Inch) LO PLATE 0.202 3.50 6 0.088 0.222 15 1.0 PLATE 0.197 3.50 6 0.102 0.262 20 1.0 PLATE 0.197 3.50 6 0.102 0.203 20 1.0 PLATE 0.197 3.50 6 0.102 0.203 20 1.0 PLATE 0.204 3.50 6 0.102 0.203 20 1.0 PLATE 0.204 3.50 6 0.102 0.203 20 1.0 PLATE 0.204 3.50 6 0.102 0.203 20 1.0 PLATE 0.204 3.50 6 0.104 0.203 20 1.0 PLATE 0.204 3.50 6 0.104 0.203 20 1.0 PLATE 0.204 3.50 6 0.042 0.203 20 1.0 PLATE 0.204 3.50 6 0.042 0.203 0.203 1.0 PLATE 0.204 3.50 6 0.042 0.555 1.5 1.0 PLATE 0.204 4.00 6 0.042 0.555 20 1.0 PLATE 0.204 4.00 6 0.060 0.555 20	RAC	Я	۸N	ş	Ž	Ş	Ą Z	Ą	Ž	Ą	Ą.	Ą	Ą	
SPECIMEN DIME (Inch) 1.0 PLATE 0.202 3.50 6 1.0 PLATE 0.202 3.50 6 1.0 PLATE 0.202 3.50 6 1.0 PLATE 0.202 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6	111	Q (Ksi)		_	<u> </u>	<u>L</u>	Щ	L	15	15	8	15	8	
SPECIMEN DIME (Inch) 1.0 PLATE 0.202 3.50 6 1.0 PLATE 0.202 3.50 6 1.0 PLATE 0.202 3.50 6 1.0 PLATE 0.202 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6 1.0 PLATE 0.204 3.50 6	SNC	Jc [!]	0.222	0.252	0 282	0.30	0 279	0 312	0.790	0.550	0.550	0.555	0,555	
ORIGINAL ORIGINAL ORIGINAL	ENSI	j ⁶	0.088	0.102	0.108	0.120	0.110	0.124	0.080	0.042	0.051	0.043	0.060	
ORIGINAL ORIGINAL ORIGINAL	I DIN	7	9	စ	မ	9	9	9	_	9	ဖ	9	9	
ORIGINAL ORIGINAL ORIGINAL	SIMEN (1	350	3.50	350	3.50	3.50	3.50	-	-	6.0	9,4	5	
OBIGINAL OBIGINAL	SPE(3	0.202	0.202	0.197	0.197	40%	200	0.205	0.201	0,201	0.20	0.204	
TANDIAL LLLLLLLDRIGINAL			PLATE	PLATE	PLATE	PLATE	PI ATE	PLATE	PLATE	PLATE	PLATE	PLATE	PLATE	
			2	10	5	10	2	9	2	0	10	0	0.	
		IDENTIFICATION	CA24-2	CA24-2	CA24-3	CA24-3	CA24.4	CAZEA	CA21-2	CA21-5	CA21-5	CA21-6	CA21-6	

* SEE FIGURE 13

(1) PREVIOUSLY TESTED
(2) CYCLED TO FAILURE
(3) CYCLED TO BREAKTHROUGH

Table 46: -320 F Surface Flawed Cyclic Flaw Growth Tests of 2219-T87 Aluminum Alloy, WT Propagation Direction (Thickness >0.25 inch)

	BELEBENCE	5	2	5	5	5	5	2	5	2	2	5	9	9	·0	9	9	13	13	13	13	5	
	COMMENTS	1,2)	(1,2)	W/2c < 4	1,2)	(1,2)			(2)	(1,2)			(2) 72c. <4	12175c54	$(2)^{4}/2_{c} < 4$	(2)	(2)	(2)	[2]	(2)	2)	2)	
	K ^{IĮ} (Ksi√ln.)	44.0	50.2	35.3	45.9	45.6	36.6	37.4	-	46,0	38.3	35.4	43.8	49.6	47.6	41.6	43.4	41.8	42,9	43.8	38.7	41.1	
	K ^{Iţ} (IBMIN)	42.0	45.5	31.5	42.7	42.5	35.2	35.8	•	42.8	36.8	34.1	41.0	45.0	44.0	39.5	41.2	40.2	39.2	39.8	37.9	40.0	
	K ^{I!} (Ksi√ <u>Iu")</u>	30.1	38.4	29.9	41.7	39.8	7.7	35.4	41.3	39.9	36.3	33.8	37.8	37.5	39.4	40.9	42.9	36.5	28.9	39.0	29.5	34.5	T
RESULTS	K ^{II} (IBMIN)	29.5	36.8	28.0	39.5	37.8	32.9	34.0	39.0	37.8	34.7	32.6	35.9	35.6	37.4	38.9	40.9	35,3	28.0	36.6	29.1	33.8	
RESI	DURATION (Cycles)	853	0	1400	3.2	10,1	240	100	2,3	24.4	100	258	36	599	146	5	4	6	269	22	634	109	
	Sc _f (Inch)	0.590	0,835	1,550	0,650	0.630	0.433	0.454	7	0.630	0,473	0.408	1,56	1,82	1.75	1.29	1,32	0.706	1,034	1.122	1,125	1,265	
	a _f (Inch)	0.235	0.180	0.447	0.190	0.200	0.135	0.136	~	0.210	0.148	0.125	0.46	0.59	0.45	0.32	0.29	0.232	0.342	0.316	0.446	0.473	7
	™ WAX \	16'0	0.91	0.45	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.58	0.58	0.61	0.64	0.67	0.80	99'0	0.65	09'0	09'0	٦
<u>9</u>	O _{MAX} (Ksi)	0'09	60.0	30.0	60.0	60,0	60.0	60.0	60.0	60,0	60.0	60.0	38,5	38.5	40.0	42.0	44.5	54,0	44.1	44.1	40.3	40.3	
TESTING	PROFILE *	٧	٨	A	В	В	В	В	C	c	၁	၁	٨	٨	٨	A	٧	۵	О	۵	۵	۵	\Box
٦	ย	0	0	0	0	a	0	0	ď	0	0	0	0	0	0	0	0	0	0	0	0	٥	
	FREQUENCY (CPM)	8	8	8	0.5	0.5	0.5	0.5	0,2	0.2	0.2	0.2	1	-	-	1	-	-	1	-	1	-	
Fg	ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	1
TEST PREP	SOAK TIME (Hours)	0.25 AIR	0,25	0,25	0,25	0.25	0.25		0.25	0.25	0.25	0.25	NA	NA	NA	NA	AN	AN	AM	NA	٧	Ϋ́	1
ING	CACLES (×1,000)	NA	۸A	NA	NA (NA	NA			NA	NA	NA	4~6	4~6	4~6	4~6	4~6	4~20	4~20	4~20	4~20	4~20	1
ECRACKING	A	٧V	A A	ΑN	ΝA	ΝA	ΑN	NA		NA	ΑN	٧V	90.	90.	90.	90.	90.	AN	NA	Ν	AN	٩	1
PRECF	Q (Ksi)	ΝA	¥	٧	NA	٧×	٧,	٧	٧	NA	٨٨	۲A	25	25	25	25	52	20~03	30~03	20~52	30~52	20~25	1
	Jc.	0,319	830	1,310 NA	570	530	0.393 NA	0.440 NA	0.572 NA	0,527	0.438 NA	390	1,31	1,31	1,31	1.29	1,32	.567	0.549 20-	.002	740	1.028	1
NSIO	įe	0.085 0	0.094 0.830 NA	0.322	0.154 0,570	0.138 0.530 NA	0.108	0.108 C	0.144 C	0.140	0.121 0	0.105 0.390 NA	0.31	0.30	0.31	0.30	0.28	0.160 0.567 20-	0.157 0	0.245 1,002	0.197 0.740 20-	0.257 1	Ì
N DIME (Inch)	7	7.0 0	7.0 0.7	7.0 0	7.0 0	7.0 0	7.0 0	7.0 0	7.0 0	7.0 0	7.0 0	7.0 0	11	11 0	11 0	11 0	11 0	8.0 0	8.0 0	8.0 0	8.0 0	8.0	┪
SPECIMEN DIMENSIONS (Inch)	M	5.004	Щ	5.007			5,006	_		5.004	5.005	Н	6.0	6.0	6.0	0.0	6.0					6.00	1
SPECI	1	0,399 5	404 5		400 5	399 5	398 5	400 5	403 5	,395 5	3399 5	.401 5	1.01	1.01		1.01		604 6	0.602 6.01	9.614 6.00	.240 6	1,242 6	1
	FORM	PLATE 0	PLATE 0.404 5.005	PLATE 0.799	PLATE 0,400 5.006	PLATE 0,399 5.005	PLATE 0,398	PLATE 0.400 5.005	PLATE 0,403 5.005	PLATE 0,395	PLATE 0.399	PLATE 0.401 5.007	PLATE 1	PLATE 1	PLATE 1.01	PLATE 1	PLATE 1.01	PLATE 0.604 6.01	PLATE 0	PLATE 0	PLATE 1,240 6.00	PLATE 1	1
	THICKNESS (Inch)	1.0 PI	1.0 PI	1.0 Pt	1.0 PI	1.0 Pt	1.0 Pt	1.0 Pt	1.0 Pt	1.0 Pt	1.0 PI	1.0 PI	1.0 Pt	1.0 PI	1.0 PI	1.0 PI	1.0 PI	1.25 Pt	1.25 թւ	1.25 คุ	1.25 PL	1.25 PL	\dashv
	SPECIMEN IDENTIFICATION	A3A-8	A3A-9	A38-1	A3A-10	A3A-11	A34-13	A3A-29	A3A-14	A3A-15	A3A-16	A3A-17	SBT-16	SBT-17	SBT-10	SBT-9	38T-8	COAS-4	COA6-5	COA6-6	COA12-4	COA12-5	1

SEE FIGURE 13
 FINAL FLAW SIZE ESTIMATED
 CYCLED TO FAILURE

Table 46: -3200 F Surface Flawed Cyclic Flaw Growth Tests of 2219-T87 Aluminum Alloy, WT Propagation Direction (Thickness >0.25 inch) (Continued)

	BEFERENCE	13	2	2	2	2	7	7	7	7	2	2	2	2	2	2	2	2	7	2	7	2	
	COMMENTS	(2)										(1,2)		ε		ε		ε		ε		(1)	
	K ^I Ł (Ksi√ <u>In.)</u>	34.3	35.2	56.1	60,2	57.3	55.2		31.1	0.09	3,8	50.6	33.3	51.9	40.5	49.9	41.8	49.7	45,5	53.1	41.6	54.8	
	(Ksi√In.) KIţ (IRWIN)	33.6	33.2	44.1	45,8	44.5	43.8	4.2	30.2	45.9	34.3	47.7	33.0	48.5	39.6	46.9	40.5	46.3	42.8	48.9	39.9	50.0	
	K ^{]!} (K≀i^ <u>Iu'</u>)	31.7	24.0	23,9	21,6	21,7	23.5	23.6	23,3	31.0	38.7	38.0	7.06	33,5	35.9	40.7	36.0	42.2	38.7	45,9	35.0	41.9	
RESULTS	K _{Ii} (IRWIN) (Ksi√In.)	31.0	23.5	23,4	21,3	21,4	23,1	23,1	22,9	30.2	30.4	3.5	30.4	33.2	35.1	39.8	35.3	40.9	37.6	43.2	34.2	40.1	
RES	NOITARUQ (Seloy)	47	4604	3864	6451	6617	4960	4640	3758	1045	421	314	98	454	220	31	150	8	53	19	97	88	
	Sc _f (Inch)	1,092	0.740	1.35	1.50	1.47	1.35	1,32	0.600	1.48	0.395	77.0	0,365	0.80	0.530	0.75	0.560	0.79	0.790	0.860	0.800	0.900	
	s _f (Inch)	086,0	0,260	0,420	0,425	0,380	0.400	0,450	0.236	0,440	0.166	77.0 762.0	0.166	0,300	0.205 0.530	0,265	0.204	0.280 0.79	0,152	0.250 0.860	0.120 0.800	0.260	
	™ XAM®	0.54	0.67	0,67			0.67	0.67	0.67	0,67	0.30	0.00	06.0	0,30	0.00	0.00	0.90	0.90	0.90	0.90	0.90	0.90	
ទ្វ	O _{MAX} (Ksi)	36.8	43.8	43.8	43.8	43.8	43,8	43,8	43.8	43.8	59,8	59.8	59.8	59.8	59.8	59.8	59.8	59.8	29,8	8.68 8.8	59.8	59.8	
TESTING	PROFILE CYCLIC LOADING	٥		٨	۷	٧	٧	۷	Ą	٧	٧	٨	٨	۷	٧	۷	4	٨	٨	4	٧	٨	
-	ย	0	0	0	0	0	0	0	0	0	0	0	0	С	0	0	0	0	0	0	0	٥	
	FREQUENCY (CPM)	ŀ	20	8	8		8	ଷ	8	8	8		20	8	8	8	8		8	8	20	8	
TEST PREP	PRIOR ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR	AIR	LR2	AIR	AIR	Alk	AIR	4,122	AIR	182	AIR	洲	AIR	洲	AIR	4兆	
HR PR	SOAK TIME	٧V	0.25	0,25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0,25	0.25	0.25	0,25	0.25	0.25	0,25	0.25	0.25	0.25	
ECRACKING	CACFE2 (×1,000)	4-20	٧	¥	¥	Ą	Š	NA	¥	۸	٧	NA	NA	NA	NA	٧	۲	NA	NA	NA	NA	ΑN	
RAC	a	٧	NA	¥	¥	¥	¥	Ν	Ą	A A	A S	NA	٧V	۸	¥ Y	۸	٧	٧V	٧	۷N	٧V	٧N	
PREC	Q (K²!)	ZO Z2	15	15	15	15	15	15	15	15	15	8	17	82	15	8	15	20	15	18	15	18	
ONS	Sc ^ļ	1,002	0.390	0.385	0,320	0,325	0.133 0,352	0,360	0,352	0.600	0.310	0.400	0.310	0,370	0,417	0,535	0.420	0,570	0.790	0.790	0.800	0.800	
ENSI	!e	0.276	0.114	0.114	0.095	0.093	0.133	0.123	0.124	0,240	0.132	0.170	0.131	0,169	0,162	0,208 0,535	0.166	0.208 0.570	0.102 0.790	0.157	0.079 0.800	0,122	
DIM Inch)	1	8.0	0	2	9	2	^	7	^	7	9	8	9	9	9	9	9	9	10	10	10	2	
SPECIMEN DIMENSIONS (Inch)	M	6.00	8,00	8,00	8,00	8,00	5,00	5,00	5.00	5,00	4,51	4,51	4,51	4.51	4,50	4.50	4.50	4.50	8.00	8.00	8,00	8.00	
SPE(1	1,240	0,502	0.501	0.507	0.502	0.504	0,500	0.500	0.500	0.499	0.499	0.504	0.504	0.504	0.504	0.501	0,501	0.502	0.502	0.502	0.502	
	МЯОЭ	PLATE	PLATE	PLATE 0.501	PLATE 0.507	PLATE 0.502	PLATE 0.504	PLATE	PLATE 0.500	PLATE 0.500	PLATE	PLATE	PLATE 0.504	PLATE	PLATE 0.504	PLATE 0.504	PLATE	PLATE 0.501	PLATE 0.502	PLATE 0.502	PLATE	PLATE	
	THICKNESS (Inch)	1,25	 8:	8.	8.	<u>.</u> 8	8.	8.	8.	8.	0:	0:	0.1		<u>.</u>	2	1.0	1.0		1.0	0.	<u>-</u>	
	SPECIMEN	COA12-6	0A51-1	0A51-2	OA51-5	0A51-6	0A54-1	0A54-5	0A54-6	0A54-6	CA54-1	CA54-1	CA54-2	CA54-2	CA54-3	CA54-3	CA54-4	CA54-4	CA51-1	CA51-1	CA51-2	CA51-2	

SEE FIGURE 13

PREVISOULY TESTED CYCLED TO FAILURE 3 3

Table 46: -320° F Surface Flawed Cyclic Flaw Growth Tests of 2219-T87 Aluminum Alloy, WT Propagation Uirection (Thickness > 0.25 inch) (Continued)

	BELEBENCE	2	2	2	2	14	14	14	14	14	14	14	14	14	14	14	14	<u> </u>	14	13	13	13	13	13	₽	7
	COMMENTS					W/2c4<4	W/2cf< 4	W/2cf < 4				W/2c4<4	W/2c1<4										(1)	(1)	(1)	
	K _{I∳} (Ksi√ <u>In.)</u>	44,0	54.8	49.7	54.7	42.1	44.1	40.5	43.6	49,6	46.4	43.8	J	40,3	39.4	40,9	48,8	43,3	42.5	38.1	37.8	41,2		43,7	44.6	1
	K ^{Iţ} (IBMIN)	41.8	49.9	46.4	50.0	32.9	33,9	32.3	40.1	43.6	41.9	37.2	38.3	35.2	34.6	39.6	46.5	41.9	41.0	37.3	36.5	38.7		39.7	40.2	1
	K (Kai√լu:)	40.2	44.8	39.8	50.5	29.4	28.7	31.8	29.3	28.7	28.6	34.7	35.2	35.0	34.6	36.8	36.1	36.4	35.6	30.2	35.1	27.4	37.3	29.5	34.7	1
JLTS	(K²i∧[u⁻) K ^{!!} (IBMIN)	38.9	42.4	38.6	46.8	7.92	26.3	28.2	28.4	27.9	27.9	31.9	32.2	32.1	31.8	35.7	35.1	35.3	34.6	7.62	34.3	26.8	35.9	28.5	33.1	1
RESULTS	UDRATION (celes)	11	11	14	2	1262	1047	291	990	1260	1694	144	162	18	19	.50	133	35	45	3226	749	9468	1	3239	642	
	Scf (Inch)	1.05	1.05	1.06	1.06	1.859	1,940	1.775	1.097	1.333	1,203	1.514	1.677	1.415	1.368	0.701	0.943	0.779	0,752	1.090	1.105	1.914		1,142	1.219	1
	(inch)	0.123	0.210	0.164	0.210	0.490	0.529	0.480	0.361	0.403	U.392	0.456	0.448	0.383	0.370	0.237 0.701	0.365 0.943	0.273 (0.253	0.438	0.345	0.699		0.303	0.295	1
	MAX / Q YIELD	0.90	0.90	0.90	0.90	0.43	0,43	0,43	0.66	0.66	99.0	0.54 (0.54	0.54	0.54	0.80	0.80	0.80	0.80	0.60	0.60	0.47	08.0	0.65	0.65	1
g	O MAX (Ksi)	59.8	59.8	59.8	59.8	29.2	29.2	29.2	43.8	43.8	43.8	35.4	35.4	$\overline{}$	35.4	53.2	53.2	53.2	53.2	40.3	40.3	32.0	54.0	14.1	44.1	1
TESTING	PROFILE *	۷	٧	۷	٥	۵	۵	۵	۵	O	٥	۵	٥	۵	a	۵	۵	O	C	Q	٥	٥	Q	٥	۵	1
TE	ย	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0.5	0.5	0.5	0,5	0,5	7
	ЕВЕФПЕИСА (СЬМ)	8	8	20	8	₽	-	0.1	\$	1	0.1	\$	1	0.1	B00.0	9	1	0,1	B00.d	1	1	-	1	-	-	1
TEST PREP	ENVIRONMENT	AIR	5 .8	AIR	AIR A	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	A!R	AIR	AIR	7
TE PR	(Honts)	0,25	0,25	0,25	0.25	AM	NA	Ą	NA	ΝA	٧	NA	٨N	٧	٨	NA	NA	٨N	٨N	AN	NA	NA	NA	٨	۷ ۲	7
KING	CACFE2 (×1,000)	NA	ΝA	۸A	AM	5	5	11.5	18	18	8	4	15	9	9	18	16	15	16	4~20	4~20	4~20	4~20	4~20	4~20	1
ECRACKING	Я	۷N	٧N	NΑ	AN	NA	ΝA	Ą	ΑN	NA	٧	٨	٧	٧	۷V	٧	AN	AN	ΝA	NA	٧V	NA	NA	NA	Y Y	
PREC	Q (K2i)	12	18	12	18		15	12	15	15	15	15	10	15	15	15	15	15	15	20~52	20~52	20~25	20~25	20~25	20~25	
	ус ^ј	1.05	1.05	1.06	1.06	1,226	1,175	1.319	0.569	0.544	0,548	1.176	1.203	1.181	1.164	0.594	0.576	0.597	0.561	0.776	1.037	1.02B	0.581	0.578	277ء	1
ENS!(!e	0.102	0,128	0,100	0.169	0,322	0,317 1,175	0,377	0.169 0.569	0.165 0.544	0.161	0,310	0.313	0.317	0.308 1.164	8.0 0.174 0.594	8.0 10.165 0.576	0.162	0.161	0.205	0.270 1.037	0.268 1.028 20-	0.171 0.581 20-	0.161 0.578	0.220	1
N DIM	1	10	10	10	10	8,0	8,0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0		8.0	
SPECIMEN DIMENSIONS (Inch)	M	8.00					6.00	6.00	6.00	6.00	6.00	6,00			6.00	6,00	6,00	6.00	6.00	6.00	6,00	6.00	6.01	6.01	6.00	
SPE(1	0.492	0,492	0,502	0,502	090	0,658	0,656	0.662	0.657	0.663	0.674	0.663		0.654	0.666	0,652	0.670	0,652	1,236	1.240	1.259	0.608	0,609	0.609	7
	ноям	PLATE	PLATE	PLATE	PLATE	PLATE	PLATE	PLATE 0.656 6.00	PLATE 0.663	PLATE	PLATE	PLATE	PLATE	PLATE 0.663	PLATE 0.654 6.00	PLATE 0.666 6.00	PLATE 0.652	PLATE	PLATE	PLATE	PLATE	PLATE 1,259	PLATE 0.608	PLATE	PLATE	
	THICKNESS (Inch)	1,0	1,0	1.0	1.0	1.25	1.25	1.25	1,25	1.25	1.25	1,25	1.25	1.25	1.25	1.25	1,25	1,25	1.25	1.25	1,25	1,25	1.25	1.25	1.25	
	SPECIMEN	CA51-3	CA51-3	CA51-4	CA51-4	AA-56	AA-55	AA-6	DA-29	DA-26	DA-30	AA-54	AA-5	AA-57	AA-60	DA-28	DA-46	DA-15	DA-27	C\$A12-4	C5A12-5	C5A12-6	C5A6-4	C5A6-5	C5A6-6	

• SEE FIGURE 13 (1) CYCLED TO FAILURE

Table 47: -320° F Surface Flawed Cyclic Flaw Growth Tests of 2219-T87 Aluminum Alloy, RT Propagation Direction

	REFERENCE	23	23	23	5 6	5 6	3 6	2 9	5 6	9	9	9	9	3	3	3	3	3	3	3	3	е П	٦
	COMMENTS		(3)	(3)	(2)		(2)	(2)	(2)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)				€	1
\vdash	K _{I‡} (Ksi√In.)	31.0	41.1	46.3	31,2	28,2	21.2	15,0 (10,1	55,0 (7	57.0	0.99						22.78	24.47	18.80	\mathbb{H}	4
	(Ksi\ln.)	-		_			_	_	8.5 10	4	8 59.	4	2	•	•	•	_	•	.35 22				_
	KIŁ (IBMIN)	30.1	6'86	42.0	25.7	23.0	17.6	12.8		52	52	52,	59	2 -	3 -	-	2 -	7 -	22	8 23.85	9 18.01	-	_
,,	K ^{I!} (K²i√ <u>Iu')</u>	28,7	33,4	31,9	27,9	25.4	19.5	14.2	9.6	51,8	42.5	46.1	48.8	29,62	-	34.31	29.72	37.47	22,12	22.18	17.29	26,15	
RESULTS	K _{Ii} (IRWIN) (Ksi√In.)	27.7	32,3	30.7	24.2	21.7	16,9	12,4	8,3	49.2	40.3	43.8	46,9	27,05	37,66	33,24	28.79	35.85	21,70	21,73	16,77	20.40	
RES	NOITARUO (Cycles)	360	127	459	300	500	1000	1500	5000	4	311	62	36	1774	585	977	1723	925	1000	3000	6000	205	
	Sc _f (Inch)	0,57	0.74	0.90	0.629	0.652	0,620	0.603	0.610	1.39	1.98	1,76	2.02	7	7	7	7	7	0.644	0,735	0,878	~	
	a _f (Inch)	0.21	0.28	0,31	0.152	0,154	0,148	0,136	0.137	0.40	0.65	0.49	0.51	7	٠,	۷	7	٤	0,263	0.295	0,345	-	
	MAX / Q YIELD	0,67	c,75	0.74	0.59	0.52	0.42	0,31	0.21	0.76	0.63	99'0	0.73	0.64	0.72	0,64	0,57	0.64	0,47	0.47	0.33	0.80	
g	^(Ksi) XAM	45,0	50,6	50,0	39,48	35,08 0.52	27.78 0.42	20.82	13,91	51,4	43.0	46.3	49,5	43,0	48.0	43.0	38.0	43.0	31.6	31.6	22.0	51.0	
TESTING	PROFILE *	a	٥	۵	4	۷	٨	4	4	٧	٨	۷	٧	D	O	۵	O	۵	a	۵	a	۵	
TE	Я	0	0	0	0,01	0.01	0.01	0.01	0.01	0	0	0	0	0,1	0.1	0.1	0.1	0.1	0.1	0.1	0,1	0.1	
	EBEGNENCA (CbW)	١	ı	1	9	8	9	8	8	1	1	1	1	20	20	20	20	8	20	20	20	ଷ	
TEST PREP	PRIOR ENVIRONMENT	AIR	AIR	AIR	(1)	(1)	(1)	(11)	(1)	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	
118	SOAK TIME (Hours)	ΝA	NA	Ϋ́	NA	ΑN	Y V	۷	Ν	NA	NA	NA	۸	۸	Ν	A A	Ϋ́	۷	٧	٧V	٧	Ϋ́	
CRACKING	CACFE2 (×1'000)	ΝA	A A	Ą	NA	ΑN	Ϋ́	NA	ΑN	4~6	4~6	4~6	4~6	ΑN	ΑN	ΑN	۸	ΝA	Ν	ΑN	A A	Ϋ́	
RAC	ย	NA	۷N	A N	MA	٧	٧V	NA	۷N	90'0	90'0	90'0	90'0	ΝA	۷V	٧N	٧N	٧N	٧N	٧N	٧N	٩	
PREC	Q (Kzi)	25	25	25	20	20	20	20	20	25	25	25	25	<u>≺</u> 16	ے16			≤16	≤16	≤16	≤16	≤ 16	
SNC	Σc ^j	0.50	0.52	0.50	0.600	0,620	0.601	0.593	0.602	1.30	1,31	1.32	1,31	0.577	0,769	0,761	0,742	0.882	0.608	0.611	0,762	0,610	
ENSIC	! _e	0.16	0,18	0.15	0,125 0.600	0,130 0,620	0.128 0.601	0,124 0.593	0,126 0,602	0,32	0.31	0.31	0,32	- 24	0.311	0.230 0.761	0.276 0.742	0.345 0.882	0.248 0.608	0,243	0.293 0.762	9£0.0	
og Gp Gp	7	11	11	11	NA		NA	-	NA	11	11	11	11	10	1 1	10		10	10		10	10	
SPECIMEN DIMENSIONS (Inch)	М	6,00	6,00	6,00	2.992	2.998	3010	3.009	3.014	6.0	6,0	6.0	6.0	6.74	6.75	6,74	6.74	6.74	6.75	6.75	6.75	6,75	
SPEC	1				2370	.2377		394	2385	.01												\Box	
	ноям	PLATE 0.51	PLATE 0.50	PLATE 0.50	0,237 d PLATE 0,2370	0,2377 PLATE 0,2377 2,998	0.2392PLATE 0,2392	0.2394 PLATE 1, 2394 3.009	0.2385 PLATE 0.2385 3.014	PLATE 1.01	PLATE 1.01	PLATE 1.01	PLATE 1.00	FLATE 0.642	LATE	LATE	PLATE 0.642	LATE	0.625 PLATE 0.638	PLATE 0.637	PLATE 0.631	SHEET 0.068	
	THICKNESS (Inch)	0.5		0.5	237d	2377	2392	2394	2385	1.0	1.0	1.0	1.0	0.625	.625	1,625	0.625 F	.625	.625	0.625	0.625	0.125	1
	SPECIMEN IDENTIFICATION	BS2-1 0.	BS2-2 0.	BS2-3	33 L 0.	34L 0,	3 2 0.	эег ро	37L b.	. E1-189	SBL-18	581,-23	SBL-22 [1.	ABC 25N-1 0	ABC 31N-2 0.625 PLATE 0.624	ABC 31N-3 0.625 PLATE 0.644	ABC 31N-4 0	ABC 38N-5 0.625 PLATE 0.630	A-1 0	A-2 0	A3 0	ABC 30N-1 A 0,125	

SEE FIGURE 13 10% NaOH ETCH

(1) 10% NaOH ETCH
(2) PRECRACKED IN BENDING
(3) CYCLED TO FAILURE
(4) CYCLED TO BREAKTHROUGH

Table 47: -320° F Surface Flawed Cyclic Flaw Growth Tests of 2219-T87 Aluminum Alloy, RT Propagation Direction (Continued)

	7011111111111		П	_	_	\neg		_		_ 1				7
	BEFERENCE	3	3	٣	~	3	3	<u> </u>	3	3	~	3	3	4
	ссммеитѕ	(1)	Ξ	Ξ	Ξ	Ξ	Ξ	Ξ	Ξ	(1)	Ξ	Ü	Ξ	
	K ^{‡‡} (Ksi√ <u>In.)</u>	•		•	1	•	•	•	1		_	_	•	
	K _{I∱} (IBMIN) (Kai√In.)	,		•	•	٠	•	•	•	1	•	•	٠	
	K [∏] (K₂i√ <u>Iu-)</u>	21.98	38.97	28.72	33,5	26,57	32.72	23,37	28,31	32.72	38.10	40.94	44,88	
RESULTS	K ^{Ii} (IBMIN) K ^{Ii} (IBMIN)	16.48	27.60	21,08	22.40	20,10	21,89	20,85	23,30	25.11	26.79	27,55	28.53	
RES	DURATION (Cycles)	23	1	63	1	90	2	240	75	16	7	ı	1	
	Sc _f (Inch)	~	~	۲	¿	2	~	~	7	2	٠,	٧	۷	
	(Inch)	-	1	1	t	۲	1	ţ	ţ	1	1	٦	-	
	Q MAX \ Q YIELD	0.64	0.95	0.80	0.80	0,76	0.76	0.80	08.0	0.80	0.80	0.00	0.80	
ပ	O _{MAX} (Ksi)	41.0	61.0	51.0	51.0	51,0	51.0	51.0	51.0	51,0	51,0	51.0	51.0	
TESTING	CYCLIC LOADING	٥	۵	a	٥	۵	۵	۵	q	۵	۵	٥	٥	
TE	Я	o. 1	1.0	0.1	0.1	9.	0.1	0.1	1.0	0.1	0,1	<u>.</u>	0.1	
	ЕВЕФПЕИСА (СЬМ)	8	8	20	ଛ	8	20	20	8	8	8	8	20	1
T d	ENVIRONMENT PRIOR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	T
TEST PREP	(Hours)	ž	ž	AN	Ϋ́	Ϋ́	ΑN	NA/	Ϋ́	A N	¥ Z	A N	NAN	
SNI	CACLES (×1,000)	ž	┼	٨N	Ϋ́	₹ Z	Ą	Ą	٧	Ϋ́	Ą	Ą	ΑN	
CRACKING	Я	₹	ž	ş	Š	۲	٧	٧	٨	۷ Z	۲ ک	۷ ۷	Ą	
PRECF	Q (Ksi)	^\ 16	-	-	^ 16	-	_	≥ 16	× 16	\ 	-	-	< 16	
	ус!	0.747	0.830	0,795	0.955	0.690	0.790	0,855	1,040	1,240	1 .	1,420	1,560	
ENSIC	! _e	0.040 0.747	0.045 0.830	0,040 0.795	0.045 0.955	0.037 0.690	0.044 0.790	0.040 0.855	0.050 1.040	0.058	0.066	0,070 1,420	0.075 1.560	
Pop Pop Pop Pop Pop Pop Pop Pop Pop Pop	٦	2	2	9	2	2	9	2	5	2	10	10	10	
SPECIMEN DIMENSIONS (Inch)	W	6.76	6.76	6.76	6.75	6.76	8.75	6,76	6,75	6.76	6.75	6.76	6.76	
SPEC	1	0.067		0.065	0.064	0.063	0.062	0,101	0,100	0.101	0,100	001	0,100	
	ноям	0.125 SHEET	_	SHEET	0,125 SHEET	0.625 PLATE 0.063	0.625 PLATE	0.125 SHEET 0.101	0.125 SHEET 0.100	0.125 SHEET	0.125 SHEET 0,100	0,125 SHEET 0,100	0,125 SHEET 0,100	
Γ	THICKNESS (Inch)	2,125	3,125	3.125	3.125	1,625	3,625	3,125	1125	3,125	3.125	3.125	3,125	
	SPECIMEN SPECIMEN	ABC 39N-2		ABC 39N-3A0,125 SHEET 0,065	ABC 48N-5	ABC 35N-1	ABC 38N-2	ABC 40N-1	ABC 50N-2	ABC 60N-3	1	ABC 70N-4	_	

SEE FIGURE 13 CYCLED TO BREAKTHROUGH Ξ

Table 48: -423° F Surface Flawed Cyclic Flaw Growth Tests of 2219-T87 Aluminum Alloy, WT Propagation Direction

_	ייבר בתבועטב	اء	اء	רַ		٦	٦				ا ي		٦	<u></u>	<u>ت</u>	<u></u>	13	<u></u>	13	13	13	13	13	13	೮	٦
 -	REFERENCE		2	2	<4 5	2	2	2	2	S.	2	2	2	-	-	-	-	+	ᅴ	듸	ᅴ	ᅴ	7		_	\dashv
	COMMENTS	(1,2)	(1,2)		×26 <	Ξ					Ê	Ξ		(2)	2	(2)	<u>(2</u>	2	2	(2)	(2)	(2)	(1)	Ξ	Ξ	
	K _I (Ksi√ <u>In.</u>)	41.7	44.2	34,9	34.8	4.7	43.2	37.3	34.3	34.7	44.7	4.5	38.9	39.0	49.9	38.3	41.4	£0.1	44.3	37.5	39.6	34.0	48.0	42,9	50.1	
	K _I f (IRWIN) (Ksi√In.)	40.6	42.4	33.9	31.8	42.6	41,4	36,1	33,3	33.7	42.6	42.5	37.7	37.4	43.1	36.3	40.7	39.1	40.3	36.8	38.2	32.8	45,0	39.2	43,2	
	K [∐] (Ksi√ <u>In.</u>)	33.3	39.1	32.6	33,7	41.5	39.4	35.1	32.6	32.9	41.4	38.8	34,6	34.7	28.3	30.2	30.2	34.0	27.4	30.0	34.2	26.7	35,8	28,7	34,3	1
RESULTS	K ^{II} (IBMIN) (Ksi√ln.)	32,6	37,5	32.0	31.2	39.5	37.7	34.1	31.9	32.2	39.4	37.2	33.7	33,8	27.5	29.1	29.8	33,4	26.8	29.6	33.5	26.1	34.7	27.8	32.7	7
RESI	DURATION (Cycles)	244	47	175	274	14.5	27,5			110	9.6	58	105	82	1,043	259	635	143	1,497	6,238	1,542	10,866	1,475	7,530	1,985	
	Scf (Inch)	0.470	0.520	0,340	1,430	0,540	0.500	0,383	0,333	0,338	0.540	0.525	0,412	0.640	1.296	0,875	1.294	1.213	2,208	1,063	1.203	1.417	3.924	950.	1.301	7
	a _f (Inch)	0.187	0,185				0.173	0.126	0.102 0	0,106		0,185	0.146		0,392	0.319	0,558	0,456	0.665 2	0,427	0,389	0.469	0,274 0,924	0.334 1.056	0,392	1
	™ AYELD	0.91	0.91	16		0.91	0.91	0.91 C	0.91 [0	0,91	0.91	0,91	0,91		0,60	0,60	0.55	0,55 0	0.44	0,55 0	0.55 0	0440		0.60	0.60	┪
(C)	O _{MAX} (Ksi)	65.0	65.0	65.0	32.5	3	71.3	71,3	71,3	71,3	71,3	71,3	71.3	54.0	1.4	44.1	40,3	40.3	32.0	40.3	40.3	32.0	54.0	14.1	1.4	1
TESTING	PROFILE *	٧	4	∢	<	В	8	8	В	ပ	၁	ပ	၁	۵	۵	۵	۵	۵	۵	۵	a	۵	a	D	۵	7
TES	¥	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	9.0	0.5	0.5	0.5	0.5	7
	ЕВЕДИЕИСУ (СРМ)	20	8	8	8	0.5	0.5	0.5	0.5	0.2	0.2	0.2	0.2	-	1	1	-	-	-	-	1	1	1	1	-	7
H= 0.	ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	╗
TEST PREP	SOAK TIME (Hours)	0.25	0.25	0.25	0.25	0,25	0,25	0,25	0,25		_	0,25			NA	Ν	AA	A	NA	ΑĀ	NA	NA	ΝA	NA	4 Z	7
NG.	CACLES (×1,000)	۷	ΨN	ΑN	ΑN	NA	NA	NA	ΑN	٩	۸	NA	NA	4~20	4~20	4~20	4~20	4~20	4~20	4~20	4~20	4~20	4~20	4~20	4~20	7
CRACKING	Я	٨	٨	٧	 	Ν	AN	٨	ş	ž	ž	NA	-	ΑN	NA	NA	ΑN	ΑN	NA	Ν	NA	NA	۷	ΝA	٧	1
PRECR	Q (Ksi)	٧×	٧	Ϋ́	₹ Z		A.A	¥ N	Α̈́		-	NA N	ΑĀ	20~25		20~25						20~25				7
	Jc [!]	0.34C N	-	_			447 N		_							603	2776 P		1.017	0,7852			.570 2	546 2	.761 2	7
NSIOI	'e	0.086	0,116 0	0.084 0.323	0.333 1.430	0,127 0,495	0.118 0.447	0.099 0.359	0.085 0.320	0.084	0,125 0,496	0,112 0,443	0,092 0,363	0,152 0,522	0.153 0.538	8.0 0,172 0,603	8.0 0.211 0.776	0,266 0.971	0,273	0,201	0.265 0.988	8.0 0.261 0.967	8.0 0.152 0.570 20~	0,159 0,546 20~	0.216 0.761	1
DIME	ר	4.0	4.0	7	7		4.0		_	_	_	4.0			8.0	8.0	8.0	8.0	8.0 0	8.0	8.0	8.0 0	8.0	8.0	8.0	\dashv
MEN	M	2,250	ــــ	↓	ـ		_	-	_	ـــــ	1	2,251		Н	Н	\vdash	Н		\vdash	6.00	6.00	3,00	6.01	├	₩	7
SPECIMEN DIMENSIONS (Inch)	1	0.399 2	0,402 2	0.399 2.250	799	.401	1,400 2	400	0,401 2,250	0.401 2	0.400	0.401 2	0,400 2,252	0.608 6.01	0.609 6.01	0.608 6.01	1,240 6.00	1,246 6.00	1.237 6.00	1.240	1,239	1,239 6.00		⊢	909'0	1
	FORM	PLATE 0				PLATE 0.401 2.250	PLATE 0.400 2.249	PLATE 0.400 2.250	PLATE	PLATE 0	PLATE	PLATE 0			PLATE	PLATE 0	PLATE 1	PLATE 1	PLATE 1	PLATE 1	PLATE 1	PLATE 1	PLATE 0.606	PLATE 0.607	PLATE 0	1
 	THICKNESS (Inch)	1.0	Т		1	T	Г			Π	П	Г			1.25 PI			1.25 PI	1.25 PI	-	_	_		_		
	SPECIMEN IDENTIFICATION ORIGINAL	A2C-6	T	T	Ţ	┢	A2C-10	A2C-11	A2C-16	┢	T	A2C-14	A2C-15		COA6-8	COA6-9	COA12-7 1	COA12-8 1	COA12-9 1	C5A12-7 1	C5A12-8 1	-	┯	┢	┥	

* SEE FIGURE 13
(1) FINAL FLAW SIZE ESTIMATED
(2) CYCLED TO FAILURE

Table 49: -423° F Surface Flawed Cyclic Flaw Growth Tests of 2219-T87 Aluminum Alloy, RT Propagation Direction

	BEFERENCE	3	3	3	3	3	3	3	3	3	3	
	соммеитѕ	(1)	Œ	(1)	(1)	(1)	(2)		(2)		(2)	
	K _I f (Ksi√In.)	-	•	•	,	ı		16,14	•	25.33 26.60		
	K _I i (IRWIN) (Ksi√in.)	-	,	•		,	•	15,59	•	25,33	•	
	K [∐] (Kại∧ <u>lu-)</u>	19.90	22.86	35.68	34.44	32.50	29.58	15,53	33.71	23.60	37.70	
RESULTS	(Ksi√ln.) K¦i (IRWIN)	17.10	16,51	22,59	23,96	22,09	28.97	15,00	32,70	22.91	35.61	
RESI	DURATION (Cycles)	398	162	8	5	4	1373	3000	504	2000	315	
	Sc _f (Inch)	7	7	1	7	۲ (7	0,801	١	0.930	7	
	a _f (Inch)	ţ	ı	ţ	ţ		7	0.310	7	0.360	٤	
	MAX / Q YIELD	0.70	0,57	0.71	0.78	0,71	0,60	0,28	09.0	0.42	0.60	
ပြ	O _{MAX} (Ksi)	49.3	40.0	0.03	55.0	50.0	43,0	20.0	43.0	30.0	43.0	
TESTING	PROFILE	a	٥	٥	Q	٥	٥	٥	D	۵	D	
TE	R	0.1	0.1	0.1	0.1	0.1	0,1	0.1	0.1	0.1	0.1	
	EBEGNENCA (CbW)	20	20	82	8	20	20	8	20	20	20	
드	ENVIRONMENT PRIOR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	
TEST PREP	(Honis)	٧	ΑN	٧N	٧	ΑN	٧	ž	ΑN	NA	ΑN	
ECRACKING	CACFE2 (×1,000)	٨N	٧N	ΑN	٧N	ΑN	AN	٨	ΝA	ΝA	ΑN	
RACI	ย	Ą	ΝA	AN	٧V	ΝA	ΝA	٧	NA	NA	Ϋ́	
PRECI	Q (K²i)	≥ 16	≥ 16	<u>≤</u> 16	<u>^</u> 16	<u>≤</u> 16	≤16		<u>≤</u> 16	<u>^</u> 16	I ←	
	ус ^ј	0.633	0.805	0.800	0,795	0.980	0,578	0.750	0,740	0,760	0,875	
ENSIC	l ⁶	0.024 0.633	0.043 0.805	0.050 0.800	0.045 0,795	0.047 0.980	0.229 0.578	0,274 0,750	0.284 0,740	0.296 0,760	0.342 0.875	
Inch)	7	2	10	9	9	10					_	
SPECIMEN DIMENSIONS (Inch)	W	6,74	6,76	6.75	6.75	6.75	6.75	6.74	6,75	6.68	6,75	
SPEC	1	0.065	890'0		0.067	0.068	0.625	0.629	0.635	0.646	0,631	
	ноя	SHEET	SHEET	0.125 SHEET 0.065	0.125 SHEET 0.067	SHEET 0.068	0.625 PLATE	0.625 PLATE	0.625 PLATE	0.625 PLATE	PLATE	
	THICKNESS (Inch)	0.125	0.125	0.125	0,125	0.125	0.625	0.625	0.625	0.625	0.625	
	SPECIMEN	ABC30H-1	4ВСЗЭН-2	ABC 39H-3	ABC 39H-4	ABC 48H-5	ABC 25H-1	ABC 31H-2	ABC 31H-3	ABC 31H-4	ABC 38H-5	

CYCLED TO BREAKTHROUGH CYCLED TO FAILURE 2 3

Table 50: Elevated Temperature Surface Flawed Cyclic Flaw Growth Tests of 2219-T87 Aluminum Alloy, WT and RT Propagation Direction

		_								- 40		
	REFERENCE	8	-		92	26	26	26	92	97	92	Ц
	соммеитѕ	(2,3,6)	(2,3,5,8	(2,3,6,8)	(2,4,5)	(2,4,6)	(2,4,7)	(2,4,7)	(5,4,6)	(2,4,6)	(2,4,6)	
	K ^{I‡} (K²i^ <u>luʻ</u>)	15,4	14.3	13.9	10,8	11,6	10,3	9.9	10,4	15.6	18.3	
	K _I t (IBMIN) (Kai√In.)	13,0	12.4	12.2	8.9	9,2	8.7	8.5	8.7	13,2	14.8	
	K (Ksi√ <u>In'</u>)	13,1	13.5	13.0	6.6	9,7	9,8	9'6	8.6	14.6	15.7	
RESULTS	K ^{II} (IBMIN) (Kai √In.)	11.8	12.0	11.7	8.5	8.4	8.4	8.3	8.4	12.7	13.6	
RES	NOITARUD (Seloy)	2000	1000	1000	2000	2000	2000	2000	4000	1500	1500	
	Sc _f (Inch)	0.299	0.285	0.265	0.629	0.671	0,138 0,605	0,130 0.603	0.629	0.615	0.667	
	s ^t (Iuch)	0.080	0,071	0,070	0,147	0,165 0.67	0,138	0,130	0,143	0,137	0,154	
	MAX / Q VIELD	0.72	0.64	0.72	0.32	0.36	0.42	0.41	0.36	0.54	0.58	
<u>5</u>	(Ksi) XAM	28.00	28.00	28.00	14.08	13,95	14.03	13,92	13.84	21,01	22.42	
TESTING	PROFILE * *	۷	4	٧	4	۷	4	٨	٨	¥	A	
TE	ម	0.10	0.10	0.10	0,05	0.05	0.05	0,05	0.01	0,01	10,0	
	ЕВЕФПЕИС А (СЬМ)	8	99	9	69	89	8	8	9	60	9	
Fe	ENVIRONMENT	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	Ξ	(1)	
TEST Prep	SOAK TIME	NA	٧	٨	٧	ΑN	٧	٧V	NA	٨	NA	
SNE	CACLES (×1,000)	ΝA	٨	٨	AN	NA	٨	NA	NA	٧V	NA	
CRACKING	Я	ΝA	ΑN	Ą	AN	ΝA	Ą	¥	ΑN	۷ ۷	ΑN	
PREC	Q (Kej)	20	8	20	82	8	8	8	8	8	8	
SNC	Sc.	0.063 0.254	0.269	0,250	0,608	0,603	0,594	0,597	0.614	C.601	0.613	
ENSI	!e	0.063	0.065 0.269	0.062 0.250	0.126 0.608	0.125 0.603	0.125 0.594	0.122 0.597	0.129	0,121	0,121	
Inch)	٦	ΝA	NA	NA	NA	NA	٨	NA	NA	NA	NA	
SPECIMEN DIMENSIONS (Inch)	М	0.12521.996	1.996	1.996	3.037	3,041	3.020	3.030	3.036	3.026	2.822	
SPE(1		0,1253	0,1252						0,236		
	МЯОЭ	D.1252 SHEET).1253sнеет 0,12531.996	3.1252 <mark>SHEET 0.1252</mark> 1.996	PLATE 0.235	PLATE 0.236	PLATE 0.236	PLATE 0.237	PLATE 0.238	PLATE 0.236	PLATE 0.237	
	THICKNESS (Iuch) OBIGINAL),1252	າ.1253	7,1252	0,235	0.236	0.236	D.237	0,238	0.236	0,237	
	SPECIMEN IDENTIFICATION	18T	15T	16T	18L	191.	30°	23L	78F	30t.	31L	

* See Figure 13

10% NaOH Etch

PRECRACKED IN BENDING

WT PROPAGATION DIRECTION

RT PROPAGATION DIRECTION TESTED AT 300°F **2309€3**23

TESTED AT 350⁰F TESTED AT 400⁰F

TRACE OF DELAMINATION

Table 51: Room Temperature Surface Flawed Cyclic Flaw Growth Tests of GTA Welded 2219-T87 Aluminum Alloy Square Butt Weld Edge Preparation. No Filler Wire Used. No Post Weld Heat Treatment.

	BEFERENCE	0	ო	က	8	3	3	3	က	3	3	
	COMMENTS	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	
	K _I † (Ksi√In.)	-	1	1	-	ı		1	1	ı	-	
	K _I † (IRWIN) (Ksi√In.)	,	1	ı	-	_	-	1	ı	١	-	
	K [!] (K²i∧ <u>Iu'</u>)											
RESULTS	(Ksi√ln,) (Ksi√ln,)	17.84	24.22	16,21	20.10	22.21	8.79	7.87	10,25	12,41	10,35	
RES	DURATION (Cycles)	846	230	2095	420	203	545	561	217	33	26	
	Sc _f (Inch)	2	۷	~	7	~	7	7	2	- 2	4	
	a _f (Inch)	1	1	t	1	t	t	t	t	t	t	
	™ XAM®	0.73	0.87	0.59	0.73	0,73	0.64	0.52	0.64	0.79	0.64	
ပ	O _{MAX} (Ksi)	16.0	19.0	13.0	16.0	16,0	17,0	14,0	17,0	21,0	17.0	
FESTING	PROFILE *	a	٥	a	٥	٥	۵	۵	۵	۵	۵	
TE	ย	0.1	0.1	0.1	0,1	0,1	0,1	0,1	0,1	0.1	0.1	
	EREQUENCY (CPM)	02	20	20	20	8	07	8	20	8	20	
TEST PREP	ENVIRONMENT PRIOR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	
TE PR	(Honts)	٨N	NA	AN	NA	NA	NA	NA	NA	NA	NA	
ECRACKING	CACFE2 (×1,000)	٧	۸A	۸A	NA	A	ΑA	Ą	ΝA	AN	ΝA	
RACI	Я	٨	A	A	AN	NA	NA	ΑĀ	NA	A	AN	
PREC	Q (Ksi)	∞ 10	æ 10	æ 10	€ 10	5 10	€ 10	5 50	€ 10	≈ 10	€ 10	
	∑c ^j	1,630	2.090	2.09.0	2,090	2,565	1,285	1,680	1.689	1,630	2,060	
SPECIMEN DIMENSIONS (Inch)	ļ _ē	0.510	0,630	0,660	0,634	0,765	990'0	080	060'0	0.082	0.091	
Inch)	٦	20	8	8	82	8	8	8	8	8	8	
IMEN (W	16.0	16.0	16.0	16.0	16.0	12.0	120	12.0	12.0	12.0	
SPEC	1	1,003			0.995	0,997	0,121	0,125 120	0,126	0.133	0,121	
	ноям	PLATE	PLATE 1,001	PLATE 0,999	PLATE 0,995 16.0	PLATE	SHEET				SHEET	
	THICKNESS (Inch)	1.00	1,00	8		8	125	1.75	122	125	125	
	SPECIMEN IDENTIFICATION	AWC50R-1 1	AWC65R-2	AWC65R-3	AWC65R-4 1,00	AWC80R-5 1,00 PLATE 0,997	AWC62R-1 0,125 SHEET	AWC81R-2 0,125 SHEET	AWC81R-3 0,125 SHEET	AWC81R-4 0,125 SHEET	AWC100R-10,125	

* SEE FIGURE 13

(1) CYCLED TO BREAKTHROUGH

Table 52: -320° F Surface Flawed Cyclic Flaw Growth Tests of GTA Welded 2219-T87 Aluminum Alloy Square Butt Weld Edge Preparation. No Filler Wire Used. No Post Weld Heat Treatment.

	BEFERENCE	23	23	ន	ß	23	_	_		_		_	_	6	9	9	٦
_	301303330	12	12	1	12	-	3	3	3	3	3	3	3	-	~		-
	COMMENTS	(2)	(1,2)	(1,2)	(1,2)	(3)	(3)	(3)	(3)	<u>@</u>	(3)	(3)	(3)	<u>(3</u>	(3)	(3)	
	K ^I (Ksi√In.)																
	K _I f (IBMIN) (Kai√In.)	23.2	30.5	1	_	1	1	1	_	-	ı	-	1	ı	-	1	
	K ^{[!} (K²i√ <u>Iu·</u>)																
RESULTS	K ^{I!} (IBMIN)	21.2	25.0	21.9	22.9	21.9	23.39	15.98	23.73	27.95	26.21	9.55	9.56	10.75	14.34	12.61	
RES	NOITARUU (cycles)	360	88	125	74	26	416	3206	139	21	99	637	699	1072	12	11	
	Sc _f (Inch)	1.03	1,33	۲	7	,	,	7	١,	١,	١,	٧	7	٧	7	7	
	a _f (Inch)	0.39	0.46	+	1	1	t	1	1	1	1	1	1	1	•	+	
	QWPX /Q LIELD	96.0	1.14	96.0	96.0	96.0	0.78	0.4 9	0.7 1	0,82	0.71	0.63	0.54	63.0	0.79	0.63	
ی	O _{MAX} (Ksi)	25.0	29.0	25.0	25.0	25.0	21.0	13.0	19.0	22.0	19.0	20.0	17.0	20.0	25.0	20.0	
TESTING	CYCLIC LOADING *	٥	٥	٥	۵	٥	Q	a	٥	٥	۵	a	ū	0	a	۵	
٣	ย	٥	0	0	0	0	0.1	0.1	0.1	0.1	1.0	1.0	0.1	0.1	0,1	0.1	
	FREQUENCY (CPM)	-	-	-	1	1	20	20	20	20	20	20	20	20	20	82	
بو يا	PRIOR ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AHR	AIR	AIR	
TEST PREP	SOAK TIME	ž	4 Z	٧	Ą	_		¥2	-	$\overline{}$	Ą	ΑN	A N	٧N	AN	٧V	
ING	CACLES (x1,000)	ž	٧	ž	¥	ΝA	NA	¥	Š	٧×	٧	۲	۲	٧	ĄN	¥	
ECRACKING	ย	ş	ž	ž	ž	ΑN	ΑN	۲	۲	¥	ž	ž	Ϋ́Z	Ą	ĄZ	Ą	
PRECI	Q (Ksi)	12	12	12	12	12	≈ 10	5 10 10	28.10	2 10	2 10	ot 35	£ 10	or 20	01 35	ee 10	
	Jc!	0.89	0.91	윤.	1.36	£.	1.615	2.070	2.080	2.075	2.560	1.275	1,630	1.643	1.645	2,090	
SPECIMEN DIMENSIONS	i ⁶	0.28	0.29	0.20	0.23	0.20	0.500	0.640	0.625	0.652	0.750	0.056 1.275	0.080	0.071	0.077	0.098	
SP)	7	۵	9	9	ဖ	9	8	8	8	8	8	8	8	2	82	8	
IMEN	M	6.01	6.01	8,0	ري 90.5	6.01	16.0	16.0	16.0	16.0	16.0	11.8	11.9	12.0	11.9	12.0	
& EC	1	86.0	0.97	0.47	0.47	0.48	0.988	0.988	<u>.</u>	0.991	966.0	0.119	0.125	0.125	0,124	0.126	
	МЯОЧ	PLATE	PLATE	PLATE	PLATE	PLATE	PLATE	PLATE	PLATE	PLATE	PLATE	SHEET	SHEET	SHEET 0,125	SHEET	SHEET	
	THICKNESS (Inch)	<u>.</u>	1.0	0.5 P	5.5	3.5	8.	Г	1.00 P	1.00	1.00	7.125 S	1,126 S	3.125 S	0,125 S	0.125 S	
	SPECIMEN	ZWI-7	2WI-9	-	1079WFB,		AWC50N-1	AWC65N-2 1.00	AWC65N-3	AWC65N-4	AWCBON-5	AWC62N-1 0.125	AWC81N-2 0.125	AWC81N-3 0.125	AWC81N-4	AWC100NE 0	

* See Figure 13

2319 Filler Wire Used 283

Cycled to Failure

Cycled to Breakthrough

Table 53: -4230 F Surface Flawed Cyclic Flaw Growth Tests of GTA Welded 2219-T87 Aluminum Alloy Square Butt Weld Edge Preparation. No Filler Wire Used. No Post Weld Heat Treatment.

	REFERENCE	3	3	၉	6	8	က	3	6	3	က	
	соммеите	(1)	(1)	3	Ξ	£	ε	(1)	Έ	3	(1)	
	K ^{‡‡} (Kai√ln.)	1	1	-	1	i	١	ı	1	_	ı	
	K ^{I‡} (IBMIN) (Kai√ <u>In.</u>)		-	-	1	1	1	1	1	ı		
	K [∐] (K⁵i^ <u>Iu'</u>)											
RESULTS	(Kai Vin.) K _{II} (IRWIN)	18,38	15,90	20.73	24,86	22.92	10,06	10.29	11,56	15,30	12.65	
RES	DURATION (Cycles)	1195	3089	822	- 8 4	8	348	156	89	15	47	
	Scf (Inch)	4	~	7	~	~	~	7	4	į	į	
	a _f (Inch)	1	t	t	-	+	1	+	t	•	ı	
	MAX / Q VIELD	0.53	0.41	0.53		0.53	99'0	0,56	99.0	0.83	99.0	
٥	O _{MAX} (Ksi)	17.00	13,00	17.00	800	16.90	20.0	17.1	20.0	25.0	20.0	
TESTING	PROFILE *	a	۵	۵	٥	٥	۵	0	a	ا ۵	٥	
]#	ย	0.1	0.1	0.1	0.1	1.0	0.1	1.0	1.0	0.1	0.1	
	FREQUENCY (CPM)	ᅉ	02	20	8	8	02	20	92	20	82	
TEST PREP	PRIOR ENVIRONMENT	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	AIR	
TE PR	(Hours)	٧V	٧V	۷N	۲	AN A	٧N	٧V	٨	NA	NA	
ECRACKING	CACFE2 (× 1'000)	NA	NA	N	¥	Y V	AN	NA	AN	NA	AN	
RAC	ย	٧N	٧N	۷V	٧N	٧V	NA	NA	NA	WA	AN	
PREC	Q (Kzi)	æ 10	R≈ 10	æ 10	or ≫	e 10	01 24	æ 10	æ 10	7€ 10	r≈ 10	
	ʒc [!]	1,615	2.080	2,080	2.080	2.550	1,280	1.630	1.630	1.680	1.980	
ENSI	i _e	0,482	0,635	0.600	0.645	0,755	0.062	0.093 1.630	0.082	0.087	0.098	
N CIM	1	20	8	82	82	8	20	8	20	×	82	
SPECIMEN DIMENSIONS (Inch)	M	16.0	16.0	16.0	16.0	16.0	12.0	12.0	12.0	12.0	12.0	
SPE(1	1.003	1.000	0.998	1.001	1.006	0.125	0.175	0.122	0.122	0.123	
	НОВМ	PLATE 1.003	PLATE 1,000	PLATE 0.998	PLATE 1.001	PLATE 1,006	SHEET 0.125	SHEET 0.175	SHEET 0.122	SHEET 0.122	SHEET 0.123	
	THICKNESS (Inch)	1,00	1.00	9.1	1.00	1.00	1,125	0.125	0,125	0.125	0,125	
	SPECIMEN IDENTIFICATION	AWC50H-1 1	AWC65H-2 1	AWC66H-3 1	AWC66H-4 1	AWC80H-6 1	AWC62H-1 0.125	AWC81H-2 0	AWC81H-3 0	AWC81H-4 0	AWC100H-60	

• See Figure 13

(1) Cycied to Breekthrough

The second of the second secon

 Table A-1 : Room Temperature, Liquid Nitrogen Temperature and Liquid Hydrogen Temperature Compact Tension Fracture Toughness

 Tests of 2219-T87 Aluminum Alloy, WT Propagation Direction

			_	_			
	REFERENCE	15				_	15
	κ ^Ι κει∕ <u>ιͷ</u> ·	26.4	26.1	31.4	31.3	33.0	35.0
RESULTS	PMAX (KIPS)	3.98	4.13	4.82	4.82	5.40	5.60
RE	5% OFFSET LOAD, P _Q (KIPS)	3.88	4.05	4.60	4.72	5.10	5.53
ဋ	LOADING TAR (x1000 LB/MIN.)	5.0	5.0	6.0	6.0	6.0	6.0
TESTING	З Я∪ТАЯЗЧМЭТ (२ ⁰)	72	72	-320	-320	423	423
	ENVIRONMENT	Air	Ą	LN,	LN ₂	LH ₂	LHZ
PREP.	PRIOR ENVIRONMENT	Air	-			-	Air
TEST PREP.	(HOURS)	ı	ı	0.25	0.25	0.25	0.25
SING	(×1000) 【♪ CACFE2	28	88	31	88	ĸ	30
PRECRACKING	Я	90.0	-			_	0.06
PRE	KMAX	12.2	-			_	12.2
NS	6	1.14	1.11	1.14	1.12	1.11	1.10
SPECIMEN DIMENSIONS (INCH)	M	.252 2.001	.252 2.002	.251 2.001	.249 2.001	.251 2.000	.252 2.002
& <u>~</u>	1	1.252	1.252	1.251	1.249	1,251	1.252
	FORM	Plate	-			_	Plate
()	ORIGINAL THICKNESS (INC	2.5	_			_	2.5
	SPECIMEN IDENTIFICATION	81-21	81-22	B1-23	81-29	A2-6	A2-7

 Loading Holes Were Smaller and Farther Apart Than Recommended in AST E399-70T Cycles to Grow Last 0.10" of Precrack

Table A-2 : Room Temperature, Liquid Nitrogen Temperature and Liquid Hydrogen Temperature Three Point Bend Fracture Toughness Tests v. 2219-187 Aluminum Alloy, WT Propagation Direction.

								_	
		BEFERENCE	15	15	15	15	15	15	ŀ
		K ^I K≳I∕ <u>III</u>	36.2	36.4	41.6	43.3	48.8	47.2	
	RESULTS	PMAX (KIPS)	6.56	96.9	8.30	8.72	3.65	9.75	
	RE	(KIBS) POPD, P _Q S% OFFSET	6.53	6.94	7.93	8.36	9.21	9.18	
	qe	LOADING RATE (x 1000 LB/MIN,)	10.0	10.0	12.0	12.0	10.0	10.0	
	TESTING	BRUTAR∃9M∃T (₹ ⁰)	22	72	930	320	423	423	
		ENVIRONMENT	Air	Air	LN2	LN2	LH	LH ₂	
	PREP.	PRIOR ENVIRONMENT	Air				_	Air	
	TEST PREP.	(HOURS)	ı	ı	0.25	0.25	0.25	0.25	
	ING	(×1000) CACLES	280	8	2	8	8	8	
-	PRECRACKING	R	90.0				_	0.06	
	PRE	KMAX	12.0					12.0	
,	NOIS	8	1.27	1.24	1.23	1.22	1.24	1.22	
	EN DIMENSIONS (INCH)	ר	10.0	-				10.0	7
		M	2.500	2.500	2.502	2.502	2.502	2.503	of Present
	SPECIM	1	1.250	1.253	1.254	1.249	1.253	1.255	ט זע, י
		ьовм	Plate	-			_	Plate	-
	4)	DHICKNESS (INC)	2.5				_	2.5	1 Cen
		SPECIMEN	ı	B1-14	B1-15	A2-3	81-12	81-13	1 > Cycles to Grow I set O 10" of

Table A-3 : Room Temperature Single Edge Notch Tension Fracture Toughness Tests of 2219-T87 Aluminum Alloy, ▷

Z	(INCH)			SPE	CIMEN (DIMENSI HES)				
SPECIMEN IDENTIFICATION	ORIGINAL THICKNESS (IN	FORM	PROPAGATION DIRECTION	NOMINAL THICKNESS, t	NOMINAL WIDTH, w	NOMINAL LENGTH, L	NOMINAL FLAW DEPTH, a	^O NET ^{/ O} YIELD	K _I (KSI√IN)	REFERENCE
NA NA	1.0	Plate Plate	RW RW WR	1.0	5.0	13.0	1.50	0.47 0.47 0.45 0.45	31,6 34,4 29,3 30,4	9

No Data Available On Precracking or on Fracture Loads

Room Temperature (70 o - 75 o F) Through-The-Thickness Center Notched Fracture Texts of 2219-TB7 Aluminum Alloy Table A.4.

		Δ	Δ	Δ			Δ	Δ		Δ	Δ		Δ			Δ
	BEFERENCE	8	8	8	33	33	ಜ	33	33	33	8	83	ಜ	33	33	æ
S	ksi <u>^ in</u> k ^c	79.2	76.7	75.3	100.9	105.4	104.2	84.8	103.9	104.1	120.2	110.0	122.4	119.9	97.0	62.9
RESULTS	ONET ^{IO} YIELD	0.65	0.62	0.61	0.69	0.76	99.0	0.79	0.68	0.61	0.58	0.60	0.57	0.57	0.62	0.70
	(KSI) Qebo22	22.76	23.09	21.56	34.0	33.9	34.9	27.9	24.1	17.8	23.2	28.2	24.5	15.4	5.7	26.1
TESTING	DNIGAOL STAR	N.A	٧N	٧N	AN	AN.	٧V	AN A	ΝA	ΝA	٧V	A'A	AN A	N.A	ΝA	٧V
PREP.	ROIRG ENVIRON: JUL	٧N	٧V	Α'n	٧V	٩Z	ΝA	٧	٧×	NA	٧٧	٧×	A N	٧V	٧V	٨٧
TEST PREP.	SOAK TIME	٧¥	٧V	NA	NA	N.A	NA	٧×	AN A	ΝA	NA	AN.	٨A	NA	NA	NA
ONS	Z ^C CRITICAL	6.28	5.91	6.36	5.45	5.73	5.58	4.77	9:28	13.65	15.05	9.25	14.20	26.72	19.70	3.23
SPECIMEN DIMENSIONS (INCH)	1	≈ 28	82≂	≃28	NA	¥2	٧N	₹	٧N	₹2	٧N	٧N	٧N	٧N	NA	≈30
IMEN DIMI	М	15.95	16.29	16.29	36.0	24.0	0.84	12.0	24.0	24.0	48.0	48.0	48.0	0.84	30.0	9.8
SPECI	1	0.061	0.062	0.062	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.523
	PROPAGATION DIRECTION	WR	WR	8 .9	RW	RW	RW	RW	RW	RW	HW	RW	RW	RW	RW	RW
	мяоз	SHFET	SHEET	SHEET	SHEET	SHEET	ЗНЕЕТ	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	PLATE
(HC	DRIGINAL THICKNESS (IN	0.060	0.060	0.060	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.50
N	SPECIMEN IDENTIFICATIO	¥C	MA	00	X4A1	X4A2	X4A3	X4A5	XSAB	X4A9	X4A14	X4A15	X4A16	X4A17	X4A22	0

PRECRACKING INFORMATION NOT AVAILABLE

CARACK INTRODUCED WITH JEWELERS SAW, NO PRECRACK

Liquid Nitrogen Temperature (-320°F) Through-The-Thickness Center Notched Fracture Tests of 2219-T87 Table A-5.

Aluminim Alloy

ဗ္ဗ BELEBENCE KZI K^C NI / 102.4 60.9 98.4 0.79 64.0 RESULTS 0.75 0.67 27.52 0.65 $\sigma_{\sf NET}/\sigma_{\sf VIELD}$ (KZI) QCBOSS 28.07 37.6 37.8 TESTING LOADING RATE Š ¥ Š ¥ ENVIRONMENT ž ٧ Z TEST PREP. Y V PRIOR (HOURS) Š ∢ Z ž ٧ 2°CRITICAL . 8 6.70 6.52 SPECIMEN DIMENSIONS 15.99 ≃28 Ϋ́ ≈ 28 ž ٦ 0.062 15.99 5.0 5.0 M 0.061 0.25 0.10 ¥ ¥ ¥Α PROPAGATION NOITSERION WR 0.25 PLATE 0.060 SHEET 0.060 SHEET PLATE FORM LHICKNESS (INCH) <u>.</u> ORIGINAL X1A4 SPECIMEN SPECIMEN X6A5 ¥ Š

CRACK INTRODUCED WITH JEWELERS SAW CUT, NO PRECRACK PRECRACKING INFORMATION NOT AVAILABLE

SCRACK INTRODUCED BY EDM, NO PRECRACK

Liquid Hydrogen Temperature (-423^oF) Through-The-Thickness Center Notched Fracture Tests of 2219-T87 Aliminia Allou Table A-6.

	٨	٨	٨	٨	٨	٨	٨	٨	٨	٨	٨	٨	٨	CRACK INTRODUCED WITH JEWELERS SAWCUT, NO PRECRACK	
	5	10	8	8	5	5 (7)	10	33	33	33	33	33	<u>₹</u>	NCUT, N	ACK
	87.2	104.0	93.0	88.2	1.66	82.0	100.2	9.99	65.5	52.1	61.5	8.65	68.9	ERS SA) PRECR
	0.73	0.79	0.59	0.56	0.63	0.75	0.78	0.75	0.75	0.80	0.73	0.73	0.80	JEWEL	DM, NO
	48.1	39.2	26.32	26.25	26.85	46.20	41.2	36.4	1.04	52.7	94.9	36.3	39.9	D WITH	D 8Y E
	ΑN	A N	NA	NA	NA	A N	ΝA	A N	ΝA	NA	A A	ΑN	ΑN	TRODUCE	CRACK INTRODUCED BY EDM, NO PRECRACK
	AIR	AIR	٧V	٧V	AIR	AIR	AIR	٧V	۸A	٧V	NA NA	ΝA	۸A	ACK IN	ACK IN
	NA A	NA	۸N	NA	٩N	AN	٧V	۸A	ΑN	٧V	AN	NA	NA	Ž	S A
	2.02	3.91	6.41	5.98	6.81	1.94	3.40	1.80	1.51	0.61	1.70	1.60	1.65		
	≈ 30	≈ 30	≈ 28	≈ 28	∞ ≈	∞ ≈	≈ 30	ΑN	۸A	AN	NA	NA	NA	G INFORMATION NOT AVAILABLE	
	12.0	12.0	15.93	15.99	16.0	12.0	12.0	5.0	5.0	5.0	5.0	5.0	5.0	T AVA	
	0.032	0.032	0.062	0.061	0.125	0.125	0.125	0.10	0.10	0.10	0.25	0.25	0.25	ON NO	
_	WR	WR	WR	WR	WR	WR	WR	WR	WR	WR	RW	ЯW	RW	DRMAT	
m Alloy	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	SHEET	PLATE	PLATE	PLATE	PLATE	PLATE	PLATE	IG INF	ACKED
Aluminun	0.032	0.032	0.060	0.060	0.125	0.125	0.125	1.0	1.0	1.0	0.25	0.25	0.25	PRECRACKIN	NOT PRECRACKED
₹	UF032A-2 0.032	UH032A-2	DC	GA	UF125A-1	UF125A-2	UH125A-1 0.125	X6A7	X6A8	X6A9	X1A3	X1A5	X1A6	PRECI	₩ VOT

Room Temperature (70º -- 75ºF) Through-The-Thickness Center Notched Panel Cycle to Failure Tests of 0.060" Thick 2219-T87 Aluminum Alloy Sheet, 'VR Propagation Direction Table A-7.

		$\underline{\Delta}$	$\underline{\Delta}$	$\underline{\underline{\Delta}}$		Δ	Δ	Δ	Δ	
	BEFERENCE	8	8	8	8	8	8	8	8	
	KSI √IN KCRITICAL	74.3	74.0	76.7	72.1	79.1	75.4	79.1	79.6	
RESULTS	k2l Λ <u>ια</u> κ¹	38.6	38.4	39.1	38.3	40.3	- - - -			
RESI	DURATION (CYCLES)	121	105	689	ıes	423	243	1220	1185	
	ASITICAL (HONI)	2.62	2.62	2.82	2.58	99.9	6.63	90.9	6.81	
	TA XAM ^D BRULIAR	36.01	35.86	35.73	35.26	21.79	20.81	23.27	21.54	
5NI.	CACFIC QWAX	36.26	36.11	36.75	35.97	22.50	22.60	22.34	22.35	
TESTING	Я	0.05	0.05	0.50	0.50					
	FREQUENCY (CPM)	45~60	45~60	45~60	45~60	45~60	45~60	45~60	45~60	
PREP.	PRICR ENVIRONMENT	NA	ΝA	٧N	ΑN	٨N	ΝA	٧V	۸	
TEST PREP.	SOAK TIME (HOURS)	٧N	٧N	٧V	٧Z	٧V	٧N	۸N	٩	
ONS	Joc.	0.72	0.72	0.72	0.72	2.00	2.00	2.15	2.17	
SPECIMEN DIMENSIONS (INCH)	1	≈ 28	≈ 28	≈ 28	≈ 28	≈28	≈28	≈28	≈28	
IMEN DIM (INCH)	м	15.92	15.93	15.92	15.99	15.99	15.93	15.93		
SPEC	1	0.061	0.062	0.061	0.059	090.0	0.061	0.062	0.062	
N	SPECIMEN IDENTIFICATIO	유	AD	٧.	0.069 15.99 \$\times 28\$ 0.72 NA NA 46~60 0.50 35.97 35.26 2.58 5.91 38.3 72.1 0.062 15.93 \$\times 28\$ 2.00 NA NA 46~60 0.06 22.50 21.79 6.66 423 40.3 79.1 0.062 15.93 \$\times 28\$ 2.17 NA NA 46~60 0.50 22.34 23.27 6.08 1220 41.5 79.1 0.062 15.93 \$\times 28\$ 2.17 NA NA 46~60 0.50 22.35 21.54 6.81 1185 41.7 79.6	08	4			

PRECRACKING INFORMATION NOT AVAILABLE

Liquid Nitrogen Temperature (-320^oF) Through-The-Thickness Center Notched Panel Cycle to Failure Tests of 0.000" This 2210-191 Aliminim Allow Chest WB Properation Direction Table A-8.

J	of U.USU" Thick 2219-187 Aluminum Alloy Sheet, "44 Propagation Ulrection		nick Z	218-18	/ Alun	י שחשו	Alloy S	neer, .	יות דיני	pagario	ח נונש	caon			
ļ	0.063 16	16.01	≈ 28	0.25	٧×	٧V	45~60	0.05	50.26	48.90	1.71	40	31.5	7.08	8
0	0.061 15	15.95	≈28	0.25	٧V	٧V	45~60	0.50	49.25	48.79	2.01	1326	6'0£	87.6	8
0	0.059 15	15.99	≈ 28	0.73	٧V	٧V	45 ~ 60	90.0	45.75	43.98	2.10	20	49.1	80.7	8
FC 0.	0.060 15	15.92	≈ 28	0.72	٧V	NA	45 ~ 60	90.0	45.70	43.89	2.00	12	48.1	78.6	8
AB 0.	0.061	15.98	≈ 28	0.72	AN	NA	45~60	90.0	46.08	45.45	1.96	14	49.1	80.5	8
нв 0.	0.061 15	15.92	≃28	0.73	٧V	٧N	45 ~ 60	0.51	43.42	43.27	2.61	199	9.94	1.68	8
КC 0.	0.062 16	16.00	≈28	2.12	AN	٧V	45~60	90.0	28.06	27.67	6.52	72	51.8	96.9	8
CB 0.	0.061 15	15.92	≃ 28	2.10	٧V	NA	45 ~ 60	90.0	28.26	26.64	6.29	73	51.9	92.8	8
A.A 0.	0.062 15	15.93	≈ 28	2.15	NA	NA	45~60	0.49	28.17	29.80	5.94	360	52.4	93.0	8
KB 0.	0.062 15	15.99	≈ 28	2.12	AN	AN	45~60	0.50	28.12	27.26	6.32	477	51.9	96.2	8

[] PRECRACKING INFORMATION NOT AVAILABLE

Liquid Hydrogen (-423 0 F) Through-The-Thickness Center Notched Pansl Cycle to Failure Tests of $0.060^{\prime\prime}$ Thick 2219-T87 Aluminum Alloy Sheet, WR Propagation Direction Table A-9.

		Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
	REFERENCE	8	8	8	8	8	8	8	8
	KSI√IN) (KSI√IN)	83.7	80.9	82.7	85.6	98.3	8.66	93.6	93.5
RESULTS	(k≳i <u>^ in</u>) k!	42.0	42.4	42.1	42.9	46.5	46.7	45.4	43.9
RESI	DURATION (CYCLES)	38	45	357	358	147	177	1855	2565
	²⁶ СЯІТІСАL (HONI)	1.89	1.65	1.67	1.82	7.14	7.55	7.16	7.16
	D WAX AT FAILURE (KSI)	48.15	49.90	50.70	50.25	25.66	24.90	24.39	24.35
ING	CACFIC QWEX	51.12	51.58	51.15	51.01	26.32	26.43	25.73	24.87
TESTING	ม	0.05	0.10	0.50	0.50	0.05	0.05	0.48	0.50
NA NA 45 ~60 0.56 0.56 0.56 0.56 0.56 1.56 1.56 1.56 1.56 1.56 1.56 1.56 1	45~60	45~60	45 ~60	45 ~60					
PREP.		ΝA	NA	ΝA	۷V	NA	ΝA	ΝA	ΝA
TEST	SOAK TIME	AN	AN	ΝA	NA	NA	NA	NA	A
ONS	Jog!	0.43	0.43	0.43	0.45	1.95	1.95	1.95	1.95
V DIMENSI	٦	≈ 28	≃ 28	≃ 28	≃ 28	≃ 28	≃ 28	≃ 28	≃ 28
SPECIMEN DIMENSIONS (INCH)	м	16.01	16.01	16.01	16.01	16.00	16.01	16.01	16.01
SPEC	1	0.063	0.063	0.063	0.063	0.063	0.065	0.063	0.063
N	SPECIMEN (DENTIFICATIO	QE	RC	RF	SH	8	ЯG	RD	8

PRECRACKING INFORMATION NOT AVAILABLE

Table A-10: Tapered Double Cantilever Beam Specimen Cyclic Tests of 1.0 Inch 2219-T87 Aluminum Alloy in Room Temperature 3% Salt "Jater Solution", IVA Propagation Direction

				1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	SINE WAVE			THAPEZOIDAL WAVE	[≥ 	1		J T T T T WILL.	TRAPEZOIDAL		≥ 	15 SEC	SMIN						
	HEFERENCE		2			2			Z.			သ			5		5							
	PER CYCLE) (MICROINCHES da/du	108	140	009	09	180	320	100	120	1800	120	100	240	100	180	520	1080							
RESULTS	κ ^l (k≳l^ <u>l/n</u>)	20.0	21.4	24.0	20.0	21.4	24.0	20.0	21.4	24.0	20.0	21.4	24.0	20.0	21.4	24.0	24.0							
RES	DURATION (CYCLES)	2500	1000	250	500	500	250	200	500	250	200	200	250	200	200	250	520							
	BEINAL (INCH)	1.91	2.09	2.43	1.69	1.87	1.96	1.74	1.88	2.38	1.74	1.82	1.95	1.71	1.92	2.09	3.32							
,	PMAX (KIPS)	3.675	3.920	4.410	3.675	3.920	4.410	3 675	3.920	4.410	3.675	3.920	4.410	3.675	3.920	4.410	4.410							
TESTING	¥	0				0			0			0			۰		0							
L	(CPM)		20			20			0.5			9.0			0.2		0.2							
TEST PREP.	Р ВПОЯ ЕИ ∨! ВОИМЕ ИТ	AIR	10-14 9/10	SAN NAC	AIR	10-14 /0/10	32% NaCi	AIR	10-14 /0/16	3/2 % (VBC)	AIR	10-14 6/10	DRNI & CC	AIR	10014 8/10	527 N 148C	3%% NaCi							
TES.	SOAK TIME (HOURS)		Š			Ą			Ą			Š			۲		0.2 0 4.410 3.32 250 24.0 1080							
	JAITINI ⁸	1.64	1.95	2.28	1.66		1.88	1.69	1.82		1.67	1.77	1.77		1.83	1.96	3.05							
ONS	ר	5.00			5.00			5.00				2.00		9.00			5.00							
SPECIMEN DIMENSIONS (INCH)	ւ _կ	5.00			5.00			5.00			5.00		5.00		5.00		9.6		2.00		5.00		5.00	
	ų	2.00				2.00			2.00		2.00		2.00		3		2.00		2.00		2.00			
SPEC	THICKNESS AT (INCH)		0.80			0.80			0.80			0.80			0.80		080							
	THICKNESS , t		1.00			8.			9.			3 .8			9.		1.00							
	SPECIMEN SPECIMEN		TA-3			TAA			TA-6			TA-8			TA-5		TA-7							

GROOVE SHAPE WAS 600"V" WITH 0.01 RADIUS